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AN EXPEDITION TO MELVILLE BAY AND NORTH-EAST BAFFIN LAND: *A paper read at the Evening Meeting of the Society on 17 June 1935, by*

J. M. WORDIE

BAFFIN BAY was discovered in 1616; at the end of June Robert Bylot in command, with William Baffin as pilot, passed across what is now called Melville Bay to discover three great inlets to the north and west, which he named Smith Sound, Jones Sound, and Lancaster Sound. It marked a very big advance in Arctic knowledge, though this was not fully realized at the time; the discovery was given no prominence, but to-day it is regarded as one of the great Arctic voyages. Two centuries elapsed, and in 1817 two whalers, the *Larkins* of Leith and the *Elizabeth* of Aberdeen, attempted Baffin's route, were successful, and reached the rich whaling grounds at the mouth of Lancaster Sound. Sir John Ross' voyage which so satisfactorily confirmed Baffin's charting took place in 1818. These were the beginnings of the Melville Bay route to Lancaster Sound and thereafter it became an annual event for whaling ships, and large numbers came this way every year, provided always that it could be done before the end of July. They relied only on sail, and took risks to be first across as early as possible in the season; ships were crushed and lost; and Melville Bay has obtained a reputation on that account of unusual danger and difficulty.

The other route to Lancaster Sound is up the Baffin Land coast, but it is hardly likely to be open till the first or second week of August. The Hudson's Bay ship *Nascopie* for instance goes by this route in September each year to Ponds Inlet and Jones Sound. Melville Bay however has the advantage that it can generally be crossed by ice ships in the middle of July, and on occasion it has been navigated as early as the first week of June.[1] The expedition which I took last summer had as its object to reach Cape York during the nesting season, which meant crossing early in July, followed by a visit to Ellesmere Land reached if possible before the end of the month. We then hoped to penetrate Lancaster Sound. We had an open programme however, except

[1] Sir Clements Markham, writing in 1873, states that the average date on which the whalers crossed Melville Bay over a twenty-three year period was July 13.

that it was important in the first instance that we should reach Cape York as early as possible, and therefore must go *via* Melville Bay.

We left Aberdeen on 24 May 1934. Our ship was the Norwegian sealer *Heimen*, 129 tons gross, oil-driven and built in 1929 to replace an older ship of the same name. She was captained by her owner Lars Jakobsen, with whose ability as a seaman and ice pilot I was already very familiar, and had a crew of ten all told, made up of two watches each of four men, a cook, and a mess boy. The wardroom party numbered nine, and I had with me Dr. T. G. Longstaff as medical officer and zoologist; P. D. Baird, surveyor and geologist; Sir John Hanham, botanist; C. T. Dalgety and H. P. Hanham, ornithologists; T. T. Paterson, geologist and archaeologist; Lieut. W. E. Fletcher, R.N., navigator; and M. H. W. Ritchie as photographer.

Cape Farewell was passed on the night of June 3–4, and we reached Godhavn on Disko Island on June 8. The Greenland Administration had very kindly arranged for a supply of oil to be available at Jakobshavn in Disko Bay, and as soon as this was on board we proceeded north from Disko on June 11. The coast north of Disko was clear of ice except for scattered remnants issuing from Ũmanák Bay and the *Heimen* pushed through without difficulty. A little fog was experienced, but only occasioned a temporary hold-up, and we passed close under Sanderson's Hope late on June 13 and anchored the same night at Upernivik. At Upernivik we had bad reports, and were made aware that the ice ahead had not yet broken away from the coast, that the winter had been extremely cold, and that the present season was an unusually late one. Local opinion was very gloomy. The ice break-up is very much the effect of wind, and even though late in a particular year, a single day may see the conditions completely altered. We were not therefore prepared to abandon hope of immediate progress. Favourable winds however were absent, the weather remained more or less calm, and we did not proceed farther north till ten days later.

Upernivik is the most northerly centre of importance at present maintained by the Greenland Administration, and here are all the essential public buildings—a church, a hospital, a store, and a governor's house. Its siting is not altogether fortuitous, as it represents the farthest north point which can be reached without difficulty by ships as early as May, whereas the coastal region beyond may be barred to navigation even during part of July. Its importance therefore rests on its location at or about the point where the pack-ice pivots against the coastal islands. Navigation at this point becomes uncertain.

While at Upernivik the geologists were busy, and Paterson also was in constant touch with Greenlanders, making a collection of proverbial sayings and obtaining the details of about thirty string figures. Others were more interested in the great mountain mass known as Sanderson's Hope,[1] which stands close by, visible from 60 miles out at sea, and marking John Davis' farthest north at

[1] Following present-day usage the mountain is here named *Sanderson's Hope*. Davis however named it *Hope Sanderson*, and Baffin also speaks of it in this form. Jeffreys in a 1775 map and Sir John Ross in 1818 seem to be the earliest to speak of Sanderson's Hope with the words reversed. There seems no foundation for the idea that it was ever named *Sanderson's Hope of a North West Passage*.

the end of June 1587 on the third and last of his voyages. Our enforced stay gave an opportunity for making its ascent. The best approach is from a valley mouth about 4 miles south-west of the peak, a point easily reached by motor boat from Upernivik, past great bird cliffs, where thousands of guillemots were now on the nests. From the valley mouth mentioned the way lay by easy gradients and scree slopes to the base of the final peak, but it was fatiguing, as deep winter's snow still remained, though now nearly at the melting-point. The final cone itself is of different formation and is made up of steep little granite knobs and screes, among which a way is picked. One of our objects in climbing to this height, about 3560 feet, was the chance which it gave of seeing the pack-ice conditions along our northward route. Southward there was an entire absence of sea-ice, and the black bluff of Dark Head (Kingatak) stood up about 40 miles to the south across an open expanse of sea. The edge of the ice began a little north of west, and within were large water spaces connecting with each other for the first 30 miles. Beyond that the ice was very little broken as yet, and though it appeared we should reach Torkussâk, about 50 miles on, it was very doubtful if we would be able to go beyond that point. In other ways the outlook was unusually interesting. The mountain stands on the sea border, and inland the country is heavily trenched with fjord-like inlets, which except for occasional water pools still held their winter ice-sheets. The most striking feature was the prominence of great cliff faces or palisades 1500–2000 feet in height, emphasized by black vertical streaking and by their arrangement suggestive of master jointing on a grand scale. The blackness of the almost bare south-facing slopes was also in pleasant contrast with the snow covering of the northern slopes. If great men require a monument there can be none finer for Davis and the merchant who supported him than this great mountain landmark.

We finally sailed from Upernivik on June 22, taking an inside passage, so as to leave Kingigtok and Tugssâk on the port hand. This took us across the mouth of the Upernivik Icefjord, in and out among the great bergs which had calved in a previous season and were now working out to sea; there had been open water to this point, and it may be that the movement of the bergs had helped to break up and so facilitate the disappearance of the winter fjord-ice. Between Tuggsâk and Tasiussak there was still a considerable amount of the winter-ice remaining, worn thin however and broken into moderate-sized floes. Beyond Tasiussak the conditions changed and bergs originating in the Giesecké Icefjord were still fast in the winter-ice. It was clear therefore that further progress would have to be made outside the coastal islands. We made an effort to break out north of Uiordlersuak, which was unsuccessful, but a way was finally found round the south side of the island. This took us out towards Torkussâk (the Cone of the Dundee whalers), to the same point where the ice conditions had already been seen to be adverse from the top of Sanderson's Hope. Our forecast had proved correct, and conditions even after a week's interval had hardly altered, and we were driven inshore to anchor at Nutârmiut where some islets protected us from ice pressing in on the anchorage. From Upernivik northwards to this point—a 40-mile run—our route had been an inside passage; but the old accounts suggest that the whalers if they could do so were in the habit of making out from Upernivik till

they reached the edge of the so-called "middle-ice," and then passing up the coast wherever possible between the broken pack and the unbroken fjord-ice. In this way they would pass by successive steps along the outer islands, from Kingigtortagdlit (Brown I.) to Kingigtuarssuk (Berry Is.) to Torkussârssuk (the Wedge of Nares) and Torkussâk (the Cone). This route was partly forced on them as in May the inside passage would be still under its winter ice cover. It would only however be possible when there was an appreciable break between the pack and the fjord-ice. Such was not the case last summer, and the inside passage which we followed was the only possible course. Beyond Nutârmiut there is no further choice of routes, and only the outside coast is available.

The delay at Nutârmiut was not a long one, and on June 27 we cut our way through the now thin winter-ice, and rounding Horse Head in 73° 38′ N. found open water right across to Cape Shackleton.[1] Horse Head, which marked the limit of vision from Sanderson's Hope, had been one of our milestones; it juts out beyond the general run of coast, and it was a fair assumption therefore that after we had passed this point the ice would press less hardly against the land than at the out-jutting headland. To the west lay field-ice, but we went north-east without difficulty and across a bay to the foot of the Cape Shackleton bird cliffs. The bay in question is in the latitude of Baffin's Horne Sound, and somewhere in this neighbourhood he traded narwhal or Sea Unicorne tusks with the Eskimo, as the name commemorates. His trading with the natives may have been on the south side of the bay as he makes no mention of the great Shackleton bird cliffs. These are quite remarkable and very much more extensive than those at Sanderson's Hope. The cliffs rise steeply for about 1500 feet and can be climbed at a few places only, and offer full security therefore to almost countless guillemots and kittiwakes.

The Cape Shackleton cliffs are on the south-west side of the large island of Agparssuit. We found it convenient to proceed northwards inside the island, and then to make an almost straight course for the point of Nûgssuak Peninsula, thus passing to the west of Ûmának or Sugar Loaf Island in 74° N. We rounded the Peninsula without obstruction, but were soon afterwards held up by ice fields in Inugsulik Bay, and compelled to lie to near a small unnamed island about 8 miles north-north-west of Nûgssuak. From Nutârmiut to this point, a run of over 50 sea miles, had taken about eighteen hours. Here however we were held, with winter-ice towards the land and a confused mass of recently broken-up ice out at sea, and the next great headland, Wilcox Head, was not finally passed till ten days later. We gradually worked our way farther north, and as soon as possible made a small boat excursion to the Head, so that we might have the advantage of a view into Melville Bay from the mountains. This for the time being was decisive. In the immediate foreground near Devil's Thumb Island there were considerable water areas, formed not by melting of the ice but, as the angular edges indicated, by the rearrangement of dismembered ice floes. A ship could have manoeuvred without undue difficulty among the Ryder Islands, and as far north as Bloch Island, but beyond that the winter-ice of Melville Bay lay practically unbroken, and it was evident that further progress was at present out of the question. Improvement

[1] The earliest record which I can find of this name is on Sir John Ross' map in 1818.

View south-east from Sanderson's Hope

Devil's Thumb, Melville Bay, seen from the summit of Wilcox Head

Winter-ice, Melville Bay: looking towards Cape Seddon

might either come slowly with the advancing season, or as we hoped rapidly with strong winds from the proper quarter.

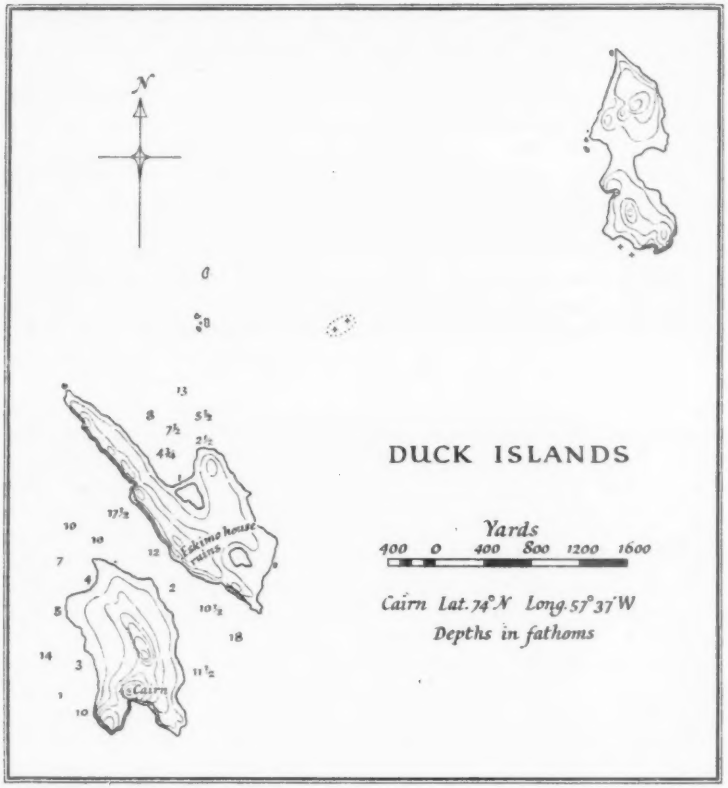
This enforced delay made possible a short visit to the Duck Islands (Kitsigsorsuit), and we went back on our tracks south-south-west for a distance of about 30 miles with fairly open ice conditions. At this date (July 4) the ice appeared to hinge on Wilcox Head, and from there the frayed edge ran south-westwards. The Duck Islands were therefore generally free from ice while we were there, though liable to temporary envelopment according to the winds and state of the tide. The islands are three in number, two placed close together to the south-west, and a third about 2 miles to the north-east. Quite possibly these are the Three Islands of Baffin, as they satisfy his statement of being just north of latitude 74° and about 8 miles from shore.

We had been led to believe that an anchorage would be found in the narrow strait between the two south-westerly islands, but this was soon seen to be a most undesirable place: a strong tide was running through the channel carrying ice-floes and bergy bits, and it was clear that there would be no security or freedom from disturbance. Quite unexpectedly however we found a good anchorage at the north-east corner of the more northern of the two south-westerly islands. The bay in question is apparently open, but three small rocks reinforced by two or three grounded bergs offer adequate protection from the north, and though the wind blew in on the anchorage the drifting floes were invariably carried past outside, east and west of the island. During the time that we were there it was evident that this was the only possible anchorage under the then ice conditions, but in spite of its advantages it does not appear that it was ever much in use as an anchorage for whaling ships, though the Duck Islands was the regular point for which they steered after leaving Horse Head in their northward progress. Combined with tides the islands break up the ice, and the whalers could always be certain therefore of some open water under their lee. Their circular look-out (now replaced by a Danish Geodetic cairn) was on the more southerly of the two south-west islands; and there are also some graves on its west side. The whaling ships would seem therefore to have avoided anchoring, and to have preferred to remain along the ice edge sending parties ashore by small boat as occasion demanded.

During our stay Fletcher took soundings and Baird made a plane-table sketch, and their map then served as a basis for the physiographical observations which Paterson was making. These dealt with the structural origin of the islands and to what extent jointing has controlled their development; and he also paid attention to glacial problems, such as the question of whether they have ever been over-ridden by a former extension of the Greenland ice-cap, and whether the snowdrifts are prominent factors in erosion.

The islands are low-lying, and the highest point (on the south-west island) is not more than 270 feet in height. The surface is grained in a north-north-west to south-south-east direction, this being the direction of the dominant joint planes. These dip very steeply westwards, and the effect is to make the west facing slopes take the form of precipitous cliffs, whilst the eastern slopes are gentler. The south-westerly island shows these characteristics very markedly and the western cliffs make a secure stronghold for the gulls and

other birds which prey on the eider ducks. The middle and south-westerly islands overlap each other very closely, and in fact appear as one from a distance, the channel between being less than 100 yards in breadth with considerable tidal movement back and forward. On the middle island immediately above the channel are some Eskimo graves and the remains of an old Eskimo house. The chief characteristic however of the island, and adding very much to its attractiveness, are the water stretches in its shallow median valley. There is both a lagoon proper at the north end with a bouldery storm-beach



cutting it off from the sea, and an equally large area of marshy tussock ground at the south end, which serves to attract a certain number of wading birds.

We sailed from the Duck Islands on July 7, and that same afternoon passed round Wilcox Head, though not without difficulty. We had now entered Melville Bay. Favouring leads in the ice led as far as the south-westerly of the Ryder Islands, but beyond that the ice was set more closely, most of it being unbroken winter-ice; progress became slow and we were checked finally about 1 mile south of Bloch Island (Kârusulik). A few Greenlanders have

Outwash-plain near Cape Christian, Baffin Land

Rounded mountains near Ravenscraig Harbour, Eglinton Fjord

Looking west up Eglinton Fjord, from the summit above Ravenscraig Harbour

their huts on the island, and a landing was made next day at what till last year was the most northerly of the villages under the Greenland Administration, though it no longer holds this distinction, as the authorities have since taken over Dr. Rasmussen's colony at Thule near Cape York. Bloch Island however has long been a natural boundary, as beyond lie many miles of ice-bound coast until the unexpectedly fertile and ice-free Thule district is reached. At Bloch Island as at other places the natives came off to meet us in kayaks, and offered carved objects in ivory or an occasional unwanted hunting weapon in exchange for such things as sugar and biscuits and tobacco, their supplies being short by now and the Danish ship not due till August. In these extreme northern stations it was interesting to find that tea rather than coffee was the popular drink, and it seems that this is due to the first European contacts having been with Scottish whalers in the nineteenth century, whereas the more southern Greenlander has acquired the continental coffee-drinking habit of the Danes. Yet another historic survival of the Dundee ships is the fact that the far north Greenlanders should include reels among their dances, as a welcome variant to a somewhat monotonous two-step and turn.

East of Bloch Island is the 1300-foot high Amdrup Island, which now became our look-out point over Melville Bay. During the next three weeks we moved about in this south-east corner of the bay, anchoring in turn at two of the Ryder Islands, at Amdrup Island, and at Devil's Thumb Island, when not working back and forwards in the ice itself.

The first survey of the Melville Bay ice from a high outlook point had been made from Wilcox Head on July 3. A second was made on July 8 from Amdrup Island. This was merely a confirmation of the first, though from a slightly different angle, and in turn showed no immediate prospect of easy progress northward. Close ice began a few miles north of the north-west Ryder Island, and from there it was possible to distinguish a line east of which there was almost smooth winter-ice, and west of which the ice was more uneven and disturbed. This in fact was the route which we were seeking, where a passage would we hoped be found, as soon as movement should begin, between the more active outer ice and the stationary winter-ice more or less land-fast round the edges of the bay.

On July 10 the ship steamed round the most southerly of the Ryder Islands, and then north, leaving the north-west Ryder Island on the starboard hand. We proceeded north along a wide open lead, varied by minor obstructions, for a distance of about 10 miles. At this point the lead narrowed, and finally stopped progress. To starboard were level floes of winter-ice and on the port side hummocky floes. We were therefore on our right track, and unless there should be very loose ice farther out to the west would follow this line—between freely moving pack and what is virtually a shore-line of undisturbed winter-ice. In close ice conditions there can be no alternative; it was the whalers' time-honoured route, and for a very obvious reason. Pack moves with the wind, and favourable winds if strong enough must therefore produce immediate open water along this line where one side is bound to remain fixed (unless the land-fast ice itself breaks up), whereas farther out in the pack there can be only fainter chances of a suitable opening taking place at the very spot where a ship should happen to lie. It is in keeping with the more general

ice-navigating rule that in close ice a ship should always work along a coast whenever possible, just where wind and tide have most chance of making open water. Next day further progress, amounting to almost 5 miles, was made along the junction line. There were only trickles of open water beyond, but the prospects of opening seemed good as a light north-east wind was blowing in our favour. The winds were again easterly on the 13th and 14th, but unfortunately never very strong, and a note was made on July 14 that this was the twelfth successive fine day. It had therefore been possible for the ice to open in two ways: in calm weather, given space beyond, the ice should have spread abroad; and with east winds, even though these were not very strong, the ice should have moved over to the west. That it had not done so was a sign that there was probably close ice extending a long way to the west, due perhaps to different winds in that quarter. The ship would either have to wait at this point for a very much stronger east wind, or else take a route much more to the south. We ultimately decided to make a reconnaissance to the south, and see what the possibilities might be.

This as it turned out was a wrong decision. There might have been some justification had we gone a long distance south, such as a couple of hundred miles, so as to round the middle-ice. The half course which we were proposing had nothing to recommend it. The former would have been the route which the Scottish whalers would have taken about this time, as they generally gave up the attempt to cross Melville Bay if they had been unsuccessful by July 15–20, and went south about in lower latitudes, so as to reach the Baffin Land coast, and then work up the west side of Baffin Bay. Their reason however for so doing rested on the fact that by this date the whales were moving south on the Baffin Land coast. For other than whaling ships there would be no particular inducement to go up the Baffin Land coast as early as this, as until August the average expectation of being able to navigate up the west side of Baffin Bay is small. With the whales coming south to meet the whalers it was of course correct for them, though not for others.

We were not prepared to go right away to the south. Instead we made a scouting sally on the 15th and 16th over a distance of about 60 miles, our farthest south being a point about 30 miles west of Horse Head. In this stretch of pack the only likely place of entry was a region of thin "winter-ice" west of Wilcox Head. By winter-ice is meant level unhummocked ice, smooth and unbroken, and practically undisturbed during its short history. Whalers used to speak of it as "bay-ice," as it was much more frequently found inshore, and "fjord-ice" is an analogous term used by Norwegians. To find thin and almost melted winter-ice at this spot meant therefore that the pack had been sluggish for a very long time. In the ordinary way sea-ice is continually on the move, and it is never very long before newly formed ice becomes first cracked and then hummocked by a kind of concertina action. The region of level winter-ice west of Wilcox Head was therefore an indication of comparatively windless conditions over a longish period, since the late winter at any rate, and a still further warning perhaps that there was close ice over in the west. At this particular spot it was wearing thin by melting, and we might have bored our way into it for some distance, but to do so would have been against all the rules. A Middle Passage, such as this would have been, is only

recommended when the ice is unusually loose, never before August even in a normal year; in effect if a Middle Passage is feasible, the Melville Bay route is equally so, as the former is merely a shortening of the distance made possible later in the year, when the Melville Bay ice has broken out. For us there was no alternative therefore but to return among the Ryder Islands till the conditions along the land-fast ice should improve.

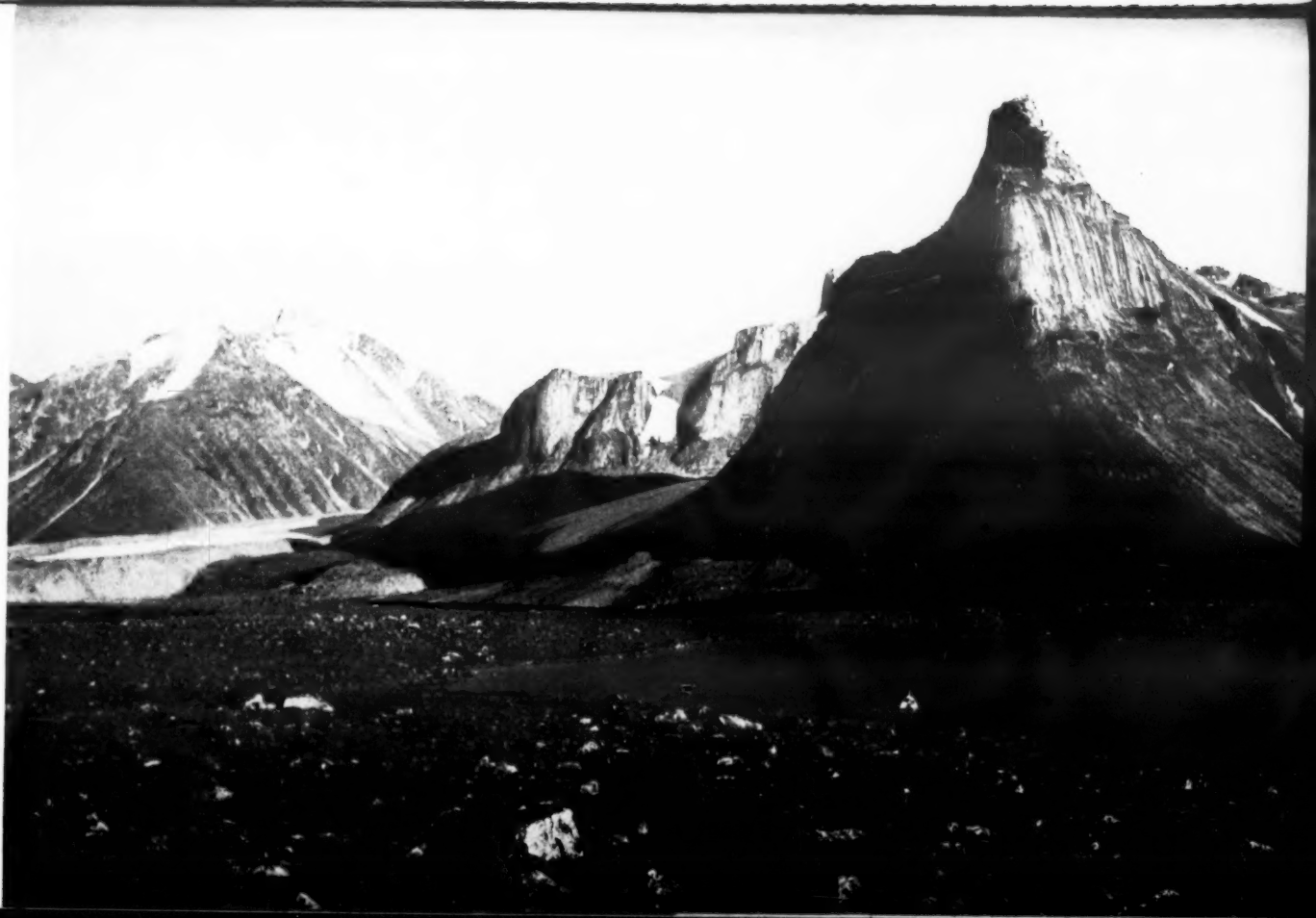
The Ryder Islands are a group of three large islands and a smaller one, arranged roughly in a triangle, with the small island as a sort of pendant to the south island, the two other large islands occupying the north-west and east corners of the triangle. None of them are much more than 1 mile in diameter, and the south island which is the highest and largest is only 480 feet high. We had no occasion to visit the east island, but we became very familiar with the others. Both are roughly circular in outline, rising to their central points by gentle steps and slopes. Cliffs are absent on the east sides, but generally present on the west, those on the south island being especially high and prominent. The rock is almost everywhere a granite gneiss producing a rather barren soil, but there is an exception on the south island where a large intrusion of dark hornblende schist, or "epidiorite," breaks down to an apparently richer soil. There were numerous lakes also in this neighbourhood, and a variety generally which made the south island the most attractive of the group. Traces of former habitation by the Eskimo are found on both. On the north-west island about two-thirds of the way up the west coast are the remains of four huts, but in process of being rapidly eaten away by the sea, so as to expose the refuse mounds alongside, and Paterson was able to make some interesting archaeological finds, of which more particular mention may be made of baleen (whalebone) boxes, and fragments apparently of baleen nets. On the south island are two more recent huts, situated at a small bay about the middle of the east coast, one hut about 40 yards back from the shore, the other at tide-level, and already subject to attack by the sea. We were able to excavate the latter in a methodical manner, and exposed the successive floor-levels, and were rewarded with a big collection of hunting and domestic equipment. It was of large rectangular pattern, and must we thought have accommodated two families at least: the floor was paved with large flat slabs, and in successive layers, as the owners had apparently made a practice of levelling up the floor and re-shaping the entrance well from time to time. Paterson made a careful study of this house, and of others seen at Bloch Island and the Devil's Thumb, and considers that their cultures can be placed in a chronological order, one being probably older than the Inugsuk culture of thirteenth to fourteenth century date excavated by Dr. Mathiassen near Upernivik. We made out that there had been scattered hunting families at Bloch Island, at Devil's Thumb, at Sardlia, and at the Ryder Islands up till the last century, dependent largely on sealing on fjord-ice for a livelihood, but that this was of too precarious a nature to prevent a movement away to the south to closer touch with more secure centres under Danish oversight such as Tasiussak and Upernivik. Recently however a re-peopling has taken place, and the government, who now extend their immediate influence much farther up the coast than formerly, have established new colonies at Bloch Island and at Devil's Thumb. Still farther north conditions are much less favourable, but

the gap across Melville Bay is almost bridged by the fact that Cape York Eskimo come south as far as Cape Seddon for winter bear hunting.

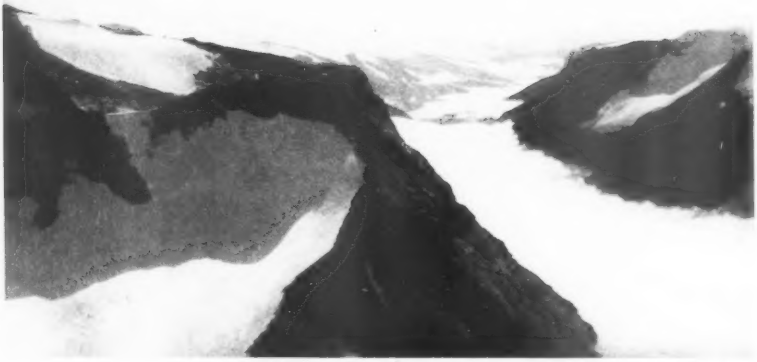
On July 22 another attempt was made to go north beyond Bloch Island, but without success, and the ship steamed back into the inner part of the bight and anchored off the Devil's Thumb. The settlement (Kuvdlorssuak) consists of eight to ten houses of turf and stones and one or two summer tents; there are more hunters than at Bloch Island; it had an air of general prosperity, and the wide spacing of the houses gave it a very cleanly and attractive aspect. Baird and Longstaff had long been hoping for a chance of climbing the Thumb, and to give them all possible assistance we immediately took them round by motor boat to the east side. This enabled them to reconnoitre the pinnacle, or rather flake, from all sides before making their attempt, and they soon found that the only possible route was from its western foot where it rises for a further 600 feet from a 1200-foot mountain shoulder. The climb succeeded, but was by no means easy; a layman might perhaps be tempted to call the route perpendicular, but Longstaff and Baird describe it in technical mountaineering language as more than "difficult" and less than "severe." They had hoped to have been the first to make the ascent, but on their return they reported that they had found a small pile of four or five stones placed together so as to form a rudimentary cairn. This cairn provided much discussion in the days that followed, some even alleging that the two climbers were victims of their own imagination, but in spite of all attempts to shake them they still maintain that theirs was not the first but the second ascent. As the earlier climb has never been reported, as would be likely if it had been climbed lately by Europeans, Longstaff and Baird hold the view that they were forestalled probably by a medical student doing his apprentice course as surgeon on one of the old whaling ships.

The Thumb is a magnificent landmark from far out at sea, and as such figures more prominently in accounts of voyages up the coast than any of the other coastal milestones. End on it resembles a badly sharpened pencil, and one naturally asks how this rock flake can have originated, and if it has been the result of unusual processes. We do not think this need have been the case, and consider that it can be explained in quite normal fashion. We had been led to expect that the rock of the Thumb was a granite, with the implication that the pinnacle itself was an intrusion which had resisted weathering, and so stood up above the surrounding gneiss. We soon found that this was quite incorrect: the rock is not a granite, and both the Thumb and the shoulder on which it stands consist of gneiss. Moreover there is no fault or break where the shoulder passes up into the higher pinnacle. Mention has already been made of the joint faces or palisades at Sanderson's Hope; similar features are also prominent in Inugsulik Bay. Paterson's view, with which I agree, was that the Thumb is of similar origin and results naturally from the close juxtaposition of two master joints, which appear as the spectacular north and south faces of the flake, and so close as to be easily joined by the more ragged east and west ends to form the present landmark.

While anchored at Devil's Thumb Island we also made an excursion by motor boat to Wandel Land, and climbed to the top of this curious table-like mountain. A small ice carapace crowns the highest point, while the rest of



Eglinton Tower,
Baffin Land



J. L. Hanham

Mist-filled valley south and south-west from Eglinton Tower

View south-west from Pioneer Peak, Eglinton Fjord

the upper part has the appearance of being an old land surface; Wandel Land may therefore be a last stronghold of an older end-product of erosion of which this portion only has withstood the attack of later lowering influences.

Wandel Land was to be our last land effort in Greenland. On July 25 we went back to Amdrup Island for a fresh view across the pack, and next day quitted the coast and steamed out due west from Wilcox Head. The crossing to Baffin Land was made in two stages. At first it had not been our intention on leaving the coast to cross immediately, but this course was gradually forced on us, and a final decision to make for Baffin Land taken on August 3. The first eight days were occupied in endeavouring to find a way into the ice between 73° and 75° N. The condition of the pack was just as unpromising however as on the similar attempt made earlier in the month, and a crossing by this route would in any case have still been a mistake, considering the very close nature of the Melville Bay ice. We were learning by experience, and it was shortly clear that there was no middle course, and we must either stick to the Melville Bay route or else go south about so as to round the middle-ice at its southern point, or at the best penetrate it near its southern limit, where it would be frayed and open. The matter was weighed up and we decided to give up the attempt on Melville Bay. We reasoned that the ice according to custom would open some time in August, and we could count therefore on reaching Cape York and Etah, but that we thought would be our limit. To reach Ellesmere Land the much heavier ice in Smith Sound would still have to be crossed; we might manage it, but once at Ellesmere Land it would clearly be a case of tip and run, and we did not feel that in these circumstances we could now ask the crew, who were already feeling their long time in the ice, to attempt so much more for such a small return. Cape York so late in the season was no longer of such interest, and we decided therefore that we should go to the Baffin Land coast instead. A return call was therefore made at Upernivik for a few hours on August 4, and from there a south-west course was set towards Cape Kater.[1]

We met the middle-ice in 71° 30′ N., 59° W., and found floes of completely different nature from those seen in Melville Bay. The ice was in fact heavy polar pack fully comparable in many ways with the immense floes which make access to the East Greenland coast so difficult and hazardous, but, unlike

[1] It is interesting to know just how far the 1934 conditions in Melville Bay were unusual or not. On our return to Upernivik the local governor reported six weeks of calm weather and almost constant fog, in his view quite abnormal. The official report has now come to hand and is more exact. The mean temperature in July was 6° C. compared with a normal of 4°·9. As regards winds 24 per cent. were from the north-east quadrant as compared with a normal frequency of 32, and 62 per cent. of the July weather was calm against 35 on the average. The lack of wind is in keeping with the higher mean temperature, and also explains the non-breaking of the ice. The August figures were equally unusual, and we are therefore justified, I think, in speaking of 1934 as an abnormally late ice year. It should be added that three ships crossed Melville Bay after we left. Favourable winds began in the second week of August, and Melville Bay was soon clear. The Norwegian *Signalhorn* and the Danish *Dannebrog*, which had only just arrived from the south, both reached Thule without hindrance on August 11, and the American schooner *Morrissey* passed across about the same time. The *Signalhorn* then attempted to reach Ellesmere Land, but was unable to cross Smith Sound on account of heavy ice.

East Greenland, the floes here remained rugged and only moderately smoothed down on the surface. They rose high from the water, and all showed signs of severe hummocking, either recently or in the remoter past, which had made the surface intensely irregular, knobs and swellings alternating with water-filled hollows and depressions. It was now high summer, the winter snow covering had melted, and on the bare ice the melted water had filled all the available hollows; by the nature of the ice these were very numerous, and this prevented any progress across the floes unless by a mixture of wading and walking. To find a way dryshod across this large-scale maze was next to impossible.

On meeting the middle-ice the *Heimen* bore left down the edge, but the latter was of very irregular outline and jutted out in a series of noses and points towards the east. This was a curious feature, and in the captain's opinion was the result of prevalent south-west winds in this region, though this had not been the case north of Upernivik; a north-west wind would in turn have frayed out the edge with south directed points. Better progress we found could be made by driving farther into the ice, and bearing left-handed at each obstruction. In 69° N. there appeared to be a chance of going straight through to the far shore, but the weight and closeness of the ice and its unfamiliarity made it inadvisable, and after some weather delays we ended by cutting through the ice near its most southern point on August 10, in 67° N. latitude and about 40 miles east-north-east of Cape Dier.

On the 11th a north-west course was made towards Cape Kater, but in the afternoon the wind began to blow strong from north-east, backing to north, and in rain and mist we ran for shelter under the land. We were not very sure of our bearings, but in the end made a landfall at Broughton Island, and came to anchor at a point about midway along its south coast where moraine country ashore had given promise from a distance of shallower water and good holding ground. We rode out the gale, and next day were able to continue northwards. Cape Kater was passed on the 13th, the mouth of Clyde Inlet during the night, and early on the 14th we made the three rounded hills which mark Cape Eglinton. From Cape Kater onwards the coast had been formed of low ground, of gravel formation, no doubt; and we had the impression that it constituted a great outwash plain left by the melting of the former Baffin Land ice-sheet. A curious feature along this stretch of low ground was the abundance of what we took to be erratic blocks, but which showed up as of immense size with square outlines. Later on we had no difficulty in confirming their erratic nature, but just at first they were a problem, and their square outline, the result probably of refraction, produced the very curious effect of a cottage-dotted landscape on an uninhabited coast.

We passed the mouth of Eglinton Fjord early on the 14th and proceeded north past Erik Point into the wide mouth of an unnamed fjord. Up till now there had been plenty of land water, but at this point these favourable conditions ceased, and as a result no doubt of the north-east gale on the 11th–12th the ice was now close against the coast beyond the unnamed fjord. We were forced back and elbowed into Eglinton Fjord to await an offshore wind which might clear the ice. At this time we had in mind to proceed up the Baffin Land coast as far as possible, having decided on this course when we left

View E.N.E. from Pioneer Peak, Eglinton Fjord

Eskimo at Clyde Post, Baffin Land

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the Greenland side. Eglinton Fjord was to be merely a temporary halting place, but as events turned out we found plenty of interest in this unexplored region, and ended by deciding to devote the time and fuel which remained to mapping and investigating Eglinton Fjord and its southern neighbour Clyde Inlet.

In contrast to the outwash plain coast which had prevailed from Cape Kater was the boss-like topography with which we first made contact at Cape Eglinton. The chart of this part of the Baffin Land coast dates from Parry's visit in 1820, when he was homeward bound from Melville Island, and the outline which was drawn then is that which still appears on to-day's charts, though no longer with Parry's explanatory notes, in one of which he emphasizes three rounded hills showing as islands from the sea. The most northerly of these marks Cape Eglinton as at present known, though originally the name, given by Ross in 1818, may have been applied to a point about 4 miles farther east. Many of the early names remain doubtful, especially when they originated from sailing ships passing down the coast but not necessarily close inshore. Parry's three rounded hills however are as distinctive as any feature on the coast, and as landmarks are both easily recognized and original in form, or in the terminology of that day "remarkable." These were the first samples of a hill type which we called alternatively bosses, big heads (the Eskimo name), or Tinto taps. Inland many more are found, and their mode of origin provided a very interesting problem in the next two weeks.

Cape Eglinton was fixed for latitude and longitude, and its astronomical position, together with that of the Hudson's Bay Post at Clyde Inlet, serve as the ends of the base for the map which was made by Baird and Fletcher during our stay. In the time available it was hardly possible to do more than draw in the coast-line and fix a few outstanding features, this being done by plane-table, and one or other of the surveyors always had a motor boat at his disposal, to take him from one station to another, zigzagging across the fjord. The same methods were also adopted in Clyde Inlet, and the two fjords were then linked together by a land traverse. The result of the mapping was a plane-table survey of over 200 miles of shoreline; but owing to the intricacies particularly of Clyde Inlet, which even now is still incomplete, this distance covers less than one degree of latitude. In the early stages at Eglinton Fjord the work was hindered by almost constant fog, but later at Clyde the conditions were as good as could be desired. Taking the map as a whole Baird does not claim more than a limited accuracy, and in particular says that some doubt attaches to the azimuth at the head of Eglinton Fjord.

Names have been added very sparingly, and if in English are for the most part translations of local Eskimo names; in this respect we were fortunate, as Paterson met two Eskimo at Clyde Inlet who supplied him with all the local names. I have put a selection only of these on the map (spelling them according to Thalbitzer's phonetic system) and have avoided using many names in Eskimo, preferring to substitute the equivalent meaning in English words. I have done so as in practice any future use of the map will be made by English- rather than Eskimo-speaking travellers, and it is also in keeping with Canadian custom, where the Geographic Board prefer that native names (Indian and Eskimo) should not be used except where the name is short and

euphonious. The greatest drawback to using native Eskimo names is probably their unfamiliar sounds and spellings—a small difference undetected by an English ear may mean much to the Eskimo—but they are also unsuitable for maps when those which describe simple natural features as they mostly do are repeated again and again at no great distance. The only native names therefore which I suggest in the present instance are the river Kogalu, meaning the big river, Naksak (big valley), Shulua (place where the wind whistles), Ikpiuja (rising land), and Adchkuja River for the river at the head of Clyde Inlet. Some Eskimo equivalents have also out of interest been added in brackets alongside English place-names. Eglinton Fjord is Abirtuja (place of whales); Cape Eglinton is Niukukualu (rounded like a head); the island called Agnes Monument is Ómujā (big boat); and Clyde Inlet is Adchkuja (the old man). The first three explain themselves. We never however discovered the significance of Adchkuja as a name for this immense inlet; it is applied also to the river coming in at the head, and I have retained it there as River Adchkuja or old man river. Besides these there are many other names, but few of any real permanent value. A certain mystery however attaches to Kingmiartaktuaja, the fjord pocket west of Naksak, translated by the Clyde Eskimo as meaning "the place where things bite things."

On entering Eglinton Fjord we anchored at Ravenscraig Harbour, a place very well known in the past to Dundee whalers who made use of it as a base during the late autumn "rock nosing," as indicated by numerous skulls and ribs of Greenland whales found along the beach. It lies at the foot of a bold north-facing bluff, whose general outline is repeated again to the west by a similar buttress-like feature. The characteristic mountain outline in these parts however, as already mentioned, is the rounded boss-like hill, typified by Cape Eglinton and recurring over a broad stretch about 10 miles in breadth, its gentle contours and sporadic nature being in contrast to the lower-lying and only minutely irregular outwash plain towards the coast. The two hills which I have called the Sledge pointers, so named as the Eskimo steer by them on leaving the coast, are representative specimens. Paterson gave much of his time to a study of this peculiar mountain form and concluded that the outline is due to frost weathering. The rock shattering which results might therefore be expected to give very poor footing, but this was not noticeably the case, and the going could always be described as relatively good. A curious feature on the scree slopes of the boss-like hills was their blotched appearance, due to the dotting about of whiter patches on the darker general background. These turned out to be due to the prevalence at certain spots of long-continuing snow drifts, which melted so late in the summer as to give no chance for the beginning of lichen growth. This was apparently the rule each successive year, and last season was in no way exceptional. The survival of these snow-drifts in late summer was in direct contrast therefore to the conditions in Greenland, and may be put down to the overcast conditions which prevail in Baffin Land. The Baffin Land climate is noticeably damp in comparison with the hard and dry atmosphere on the Greenland side. The most prominent of the snow drifts was one which extended for about 3 miles, plastered along the south face of the hills on the north side of Eglinton Fjord. It did not appear however to have any marked effect on the general outline of the slope,

and indeed the curiously haphazard occurrence of the snow drifts and the absence of obvious nivation effects remains unexplained.

The ship was moved to the head of Eglinton Fjord on August 20. A chart made by the whaling captain J. B. Walker in 1878 showed the fjord ending about 15 miles west of Ravenscraig Harbour. The reality proved otherwise and we were able to take the ship some way farther, turning sharp left for 6 miles and then sharp right for another 6 among magnificent 4000–5000 feet peaks. These were mountains which we had previously seen from Ravenscraig, noting how their glaciated and alpine appearance contrasted with the rounded mountains over in the east, and that this alpine backbone constitutes a fresh topographic type in addition to the two already mentioned. Most of these inner peaks are glaciated, carrying individual corrie glaciers, but there are exceptions: the high and curious Cockscomb for instance is for the most part ice free.

Two mountains were climbed near the fjord head. Longstaff and John Hanham reached the summit of Eglinton Tower at the extreme head on the south side; and Ritchie and Baird penetrated west to Pioneer Peak. Longstaff from his summit reported that the fjord trench continued southwards as a long ice-free valley, which was swinging round to the west to run apparently for a long distance into the interior. Beyond this valley were ice-covered rounded hills closely set together. As far as the low ground went Longstaff's report however is not quite complete, as heavy fog filled the valleys below; this fog covering was an almost constant feature, appearing each evening and lasting till the next day, when it would be blown away by an afternoon wind. Equally local was the persistent east wind in the fjord, when on the mountain tops conditions were quite otherwise. Ritchie from his peak did not see Longstaff's valley; but he and Baird saw over into the next fjord to the north-west, at present nameless, but clearly penetrating a good distance farther inland than is shown on the chart. Their photographs show heavily iced mountain country to the south-west, the ice lapping over and covering the mountains, presumably of carapace type, except due west where these shields fused to a real ice-cap and to the S.S.W. where Ritchie and Baird state that they saw the dull blue purple of ice-free country of subdued plateau form. No prominent mountains appeared in the west, but peaks of fantastic appearance were seen to the north and east in continuation of the characteristic features of the alpine belt in which they stood. Their ascent of Pioneer Peak has served to show the complex nature of Baffin Land topography, this multitude of scenic types being perhaps due not so much to rock differences as to the relative effects of glaciation either in total amount or in respect of the interval which has elapsed since the ice covering was removed.

The ship was taken round to Clyde Inlet on August 23–24. Sir John Ross had originally named it River Clyde, but the name seems inappropriate, and it is now suggested that it would be better if it could be known in future as an inlet. With the motor boat as a base Baird was able to survey about two-thirds of the district during our stay, and this work took him to the far head, a narrow extension which runs unsuspected for 30 miles farther west than is shown on Parry's chart. There had been a gap in the connection between Cape Eglinton and Clyde due to fog during the ship's passage, but this was

now set right by Fletcher and Dalgety, who took an overland route along the outer coast as far as the mouth of the river Kogalu. The river did not belie its Eskimo name of big, and a crossing was quite impossible. To reoccupy Cape Eglinton was therefore out of the question, but this was not altogether necessary as other long rays were obtained from the Sledge Pointers, and there seems a fair chance therefore that Eglinton Fjord and Clyde Inlet are now correctly placed. During this time collectors were also busy and Dr. Longstaff in particular reports an important collection of spiders; and on the river near Clyde Post the salmon trout had just begun their autumn run.

At Clyde there is not the same variety of topographic types as farther north. The outwash plain with its characteristic "kettle hole" lakes and cottage-like erratics is about 6 miles in breadth, and there is a fine group of the scree-covered and frost-shattered boss-like hills immediately behind the Hudson's Bay Post. For the rest the alpine peaks and the ice-cap country are apparently absent; steep cliffs, such as Black Bluff, border the wider part of the Inlet, and the narrow westward extension, but further in the country was reported as opening out right and left, the fjord finally ending in more or less low rounded country.

Clyde Post itself is one of two Hudson's Bay trading stations in the north part of Baffin Land. Ponds Inlet is about 200 miles to the north, and in South Baffin Land Pangnirtung is still farther away. Its importance therefore can be judged, and it is the natural centre to which the natives come from a very wide area. They are nomadic in their habits however and there are no permanent huts round the Post, whose red-roofed buildings stand out white and clean in an ordered isolation. It may be accident or design; but this absence of crowding round a centre impressed us as likely to make both for better health among the Eskimo and for the preservation of their native customs and mode of life.

We had hoped to see more of the Eskimo and to judge how the Canadian methods compare with the Danish. When we first arrived however there was only one tent at the Post, but later this single family was joined by an old couple, of whom the man, aged sixty, proudly claimed that he had never been hungry throughout his life, an unusual record for any hunter and especially among the Eskimo. All the others of the tribe were away inland caribou hunting, the skins being now at their best for clothing, but before we left another family arrived at the Post. It was dark at the time and their arrival (by whale boat) was immediately made known by the concerted howling of the dogs already at the Post. The women landed first in order to choose a suitable tent site; the sealskin tent and poles were then put ashore, and there was soon a procession up from the beach, even the smallest of the children helping to carry bundles of skins or perhaps a kettle, and to move the stones necessary for weighting down the tent flaps. The sleeping platform was then constructed, and finally the blubber lamp was lit inside the tent.

In appearance, in dress and in customs the Baffin Land natives differ very widely from the Greenlanders, though originally of common ancestry. Their nomadic nature has been specially mentioned. Numbers however are sparse, and a natural increase which one would have expected under the securer conditions to-day seems absent. In Greenland on the other hand the

population has steadily grown, and whether it be cause or effect the native there has now become a worker and a fisher, living as it were on a commercial basis. In Baffin Land a change of this nature does not at present appear likely.

In Greenland the Government and the trading monopoly are one and the same; on the Canadian side the trading is almost entirely in the hands of the Hudson's Bay Company, but the government rests with the Canadian Minister of Interior working through the Royal Canadian Police, who in the case of Clyde visit the post twice a year, once by ship in autumn, and once by dog team in winter. In connection with these contrasting methods of control the wide difference in the social attitude of the white man to the native Eskimo on the two sides must also be taken into account. In Baffin Land there is no intermingling of stock, but this is quite the reverse in Greenland, where there are now practically no natives of pure breed. It is quite impossible therefore to draw comparisons between the two methods. Two separate problems are involved, and there is no inconsistency in showing one's appreciation of both systems of government, one dealing with a native still in his primitive state, the other with a mixed race in an unadjusted transition stage.

At Clyde Post at the time of our visit all was in order for the annual inspection by both the Government and the Company. We did not however wait for the arrival of the *Nascopie*, due in the first week of September. Our own supplies of fuel were now running low: we were three months out from Aberdeen, and the crew had been continuously watch and watch throughout that time. With the first touch therefore of autumn frosts and snows we moved south to Isabella Bay, and finally on August 31 set a course for Cape Farewell, which was passed on September 5. We made a landfall at Sulisker and North Rona, and passing through the Pentland Firth reached Aberdeen on September 15.

All photographs, unless otherwise stated, are by M. H. W. Ritchie.

Note on revised spelling of place-names

The spelling of Eskimo names in Greenland is under revision by the Danish Committee for Greenland Names and the spelling of many names used in this paper will be changed, but it has not been possible to obtain the complete decisions of the Committee in time for the present publication. We shall hope to publish a revised list of names at an early date.

Certain new names proposed for Baffin Land in this paper were submitted to the Geographic Board of Canada in July and their decision has not yet been received.

DISCUSSION

Before the paper the PRESIDENT (Major-General Sir PERCY COX) said: Mr. Wordie, who is going to read the paper to-night on a recent expedition to the Canadian Arctic, is so well known to you, or ought to be, that I do not feel I need make very much introduction. He has been an explorer for the last twenty years. He was, you may remember, chief of the scientific staff of the Shackleton Expedition of 1914, and ever since then he has been, from time to time, exploring in polar regions—Greenland several times, Spitsbergen, Jan Mayen Island—and he is a thoroughly experienced and accomplished scientific explorer. The journey he is going to describe to-night was undertaken last summer. The

party were only three months away and did a great deal of excellent work. Mr. Wordie, who is a geologist primarily, will tell us of the work accomplished by his expedition, which consisted of nine members all interested in some aspect of scientific exploration. I now ask Mr. Wordie to give us his paper.

Mr. Wordie then read the paper printed above, and a discussion followed.

The PRESIDENT: We always like to have members of expeditions join in the debate. Mr. Dalgety, would you make a few observations? Mr. Dalgety was mainly the ornithological expert, but he also helped in other directions wherever he could be of service.

Mr. C. T. DALGETY: I think the best way would be for me to describe the birds we met with in three or four different places, rather than go through a list of the birds.

In Greenland the best part that we visited, from the point of view of an ornithologist, was the Duck Islands. Here there were many thousands of eider duck nesting. Mr. Wordie has told you that the Duck Islands have been reserved as a sanctuary for the eider duck in order that they may breed there and, when they have increased in numbers, spread over more of the Greenland coast. The eider duck is very important as food for the Eskimo. As to the little houses which Mr. Wordie spoke of as being built for the eider duck to nest in, we doubted whether they were built out of kindness, because one had an ingenious drop-stone entrance so that when the duck went back to sit on its eggs the stone fell down. We rather suspected that these little houses were built by people who came to collect the eggs and wanted some meat to eat as well as eggs. Besides the eider duck there were a number of snow buntings nesting here: in fact, there were more snow buntings on the Duck Islands than on any other ground we visited.

Glaucous gulls were nesting on the cliffs round and feeding on the eider ducks' eggs. The absence of skuas was remarkable. In an eider duck colony of this size in Spitsbergen there would have been ten or a dozen pairs of Arctic skuas. On the Duck Islands there were none. Further out on the ice-pack there were a few skuas, but here we only saw one—and that passed straight over. There were two or three pairs of grey phalaropes and besides these other waders such as Bonaparte's sand-piper, the purple sand-piper, ringed plover, turnstone, and knots, but there were very few of all of these. There was one white Greenland falcon, apparently without a nest or a mate, and one pair of ravens with a nest containing one young bird. There were innumerable Mandt's guillemots, which appear to be the commonest bird all over the west coast of North Greenland. The most interesting nest we found on the Duck Islands was that of the razor-bill, as it was extremely far north to find this bird. Before going to the Duck Islands I found, through talking with an Eskimo by means of signs and pictures and with the help of Paterson, who had learned something of the Eskimo language, that they were familiar with the razor-bills and had a special name for them differentiating between razor-bill and Brunnicks' guillemot. This must mean that the razor-bill is not unusual so far north.

On the islands closer to the mainland of West Greenland and the south end of Melville Bay there are very few birds. There are the Mandt's guillemots again, and large quantities of glaucous and Iceland gulls and kittiwakes, which breed on the cliffs. Brunnicks' guillemots were on the higher cliffs and they were in large colonies. There were a few snow buntings, a very few American pippits, Greenland wheat-ears, Lapland buntings, and a few rock ptarmigan. All these birds, except the sea birds, seemed to be in very small numbers.

To cross over to Baffin Land, when we got there it was already getting on in

August and many of the summer migrants had left. There were fewer sea birds. The land birds were much the same as on the other side. The waders were the purple sand-piper, Baird's sand-piper, and ringed plover. No other waders were seen in Baffin Land. There were snow bunting, Greenland wheat-ear, Lapland bunting, and American pippits. Rock ptarmigan appeared to be very numerous at the head of every fjord and on any really suitable ground. In one place, in about half a square mile, there were about fifty rock ptarmigan. There were also hares on this ground which had fairly luxurious vegetation.

Out at sea among the ice the largest bird population was at the south of Baffin Bay in Davis Strait. Here the ice appeared to be old polar ice which had cut down and broken up into largish lumps in depth but comparatively small pieces. Amongst these there were little auks and fulmars in large quantities. Farther north we could go for days without seeing the little auk, and fulmars were scarce. We would perhaps only see half a dozen in a day. Ivory gulls were not so plentiful as one would expect. In Spitsbergen, where seals are numerous one always finds a fair quantity of ivory gulls, but in Baffin Bay we would find many seals and perhaps only see one ivory gull. Again, in Spitsbergen the ivory gull will follow bears. In Baffin Bay only on two occasions did we find the ivory gull with bears, though admittedly, when we came upon bears there was usually a fog, so perhaps we would not have seen the ivory gulls or the ivory gulls would not have seen the bears.

It was a great disappointment to us not to be able to reach our objective, and it was certainly a very great disappointment to me, for I had hoped to get the birds of the extreme north: the knot, sanderlings, greater snow goose, and the Brent goose. Unfortunately we did not get there and so did not get amongst these birds. All that we did find are comparatively well known. The specimens we brought back are now at the Natural History Museum, South Kensington. I will not say more as a full report will be published in the *Ibis*.

Dr. H. R. MILL: I have to congratulate Mr. Wordie on an even greater success than the elements permitted him to command, for it is the mark of a real explorer that he should take advantage of every opportunity and not return in despair because he has not been able to do everything that he hoped to achieve. The effort to cross Melville Bay recalls many old stories of the early whalers; but the old whalers, though they knew a great deal about the regions they visited, did not, as a rule, communicate much of their knowledge to the outer world. The fact that so few exploring expeditions—that of Sir John Ross being an exception—mapped the western coast of Davis Strait makes even the few astronomical positions which Mr. Wordie's party were able to secure of great value in fixing points from which subsequent explorers will be able to add details to the outline of the coast.

There are many points in the paper that interest one, notably the occurrence of large blocks of stone standing above the coast-line almost like villages of little houses. That reminded me strongly of a similar feature on the coast-line on the west coast of Kintyre and the west coast of the Rhinns of Galloway, in Scotland. The origin of those huge square blocks of stone puzzled me greatly and I hope the further researches of Mr. Wordie's expedition will cast some light on the question.

We have also to congratulate the Society on possessing an Honorary Secretary who has not retired from the explorations which have occupied so many years of his life but who is continually inspiring the youth of the University of Cambridge to pursue, with him as a guide, a line of action which promises in the future to keep our *Journal* supplied with valuable information and our evening meetings with solid entertainment.

The PRESIDENT: I should, in the first place, like to say how we always enjoy the interesting words that fall from Dr. Mill.

You may or may not know that I spent most of my service in the Persian Gulf, a very different region from the one we have been hearing about, but a familiar figure to me in Persian Gulf history is Captain Baffin, whom we have heard so much of to-night and whose name has been prominent on the map. Captain Baffin, Mr. Wordie told us, was at that time a pilot of Captain Hall. A man of quite humble origin, he was in and about the north polar regions for five or six years. Then he took service with the East India Company, and we hear of him later on in 1622 when the English flotilla—we always kept a squadron in the Persian Gulf—were assisting the Persians to eject the Portuguese from the island of Ormuz. On this occasion we were attacking the fort on the island of Kishm, which is opposite Ormuz, the island near Bundar Abbas. Captain Baffin, who met his death on that occasion, is referred to in Purchase's 'Pilgrims,' and I would like to read you a few lines from that account: "Master Baffin went ashore with his geometrical instruments for the purpose of taking the height and distance of the castle for the better levelling of his piece, to make his shot, when he received a small shot from the castle into his belly, wherewith he gave three leaps, by report, and died immediately." Such was the end of Captain Baffin.

Dr. Mill has paid a tribute to Mr. Wordie's expedition and he has done it much better than I could, so I will not say much more in that direction. But, as you may have realized from the map you saw, there were great possibilities. If everything had been favourable we might have heard from Mr. Wordie next from the Isthmus of Panama, in quite a different part of the world! Alas, the elements were not favourable, and they were disappointed of getting as far as they thought they might hope to, but the expedition evidently did valuable work in spite of their feeling of disappointment, both in ethnological directions and in that of ornithology. There is no doubt that every such expedition helps another and adds to the general store upon which explorers when they are making their plans rely for seeing what work has been done, and they can most usefully do. I ask you to join me in thanking Mr. Wordie very much for his paper and for the excellent double photographs which he has put on the screen.

SOME METHODS AND PROCEDURE DEVELOPED DURING RECENT EXPEDITIONARY SURVEYS IN SOUTH-EAST GREENLAND

PROFESSOR N. E. NØRLUND AND MICHAEL SPENDER

The scope of the survey attempted

THE surveys to be described here took place during the two years 1932 and 1933 on three distinct expeditions. These were the Scoresby Sound Committee's Second East Greenland Expedition 1932 led by Captain Ejnar Mikkelsen, Dr. Knud Rasmussen's Seventh Thule Expedition 1932, and the continuation under the same leadership of the Seventh Thule Expedition in 1933. For the most part the programmes of map-making were of a more ambitious character than those usually associated with exploratory expeditions. An explorer's map of the coast of south-east Greenland was indeed already in existence; this had been compiled mainly from the surveys of Graah (1828–31), Holm (1883–85), Garde (1885–88), and Amdrup (1899–1900).

Surveyors coming to a coast already roughly mapped are bound to feel that nothing less than an adequate modern map can be the justifiable object of further expense of time and material. Since the end of the last century the design of instruments has made great progress; facilities for carrying out accurate survey have become available which would have amazed those naval officers who made the first map. But alone the vastness and the inaccessibility of the country had been a crushing handicap without the use of an aeroplane for survey-photography. Whereas the Geodetic Institute of Denmark undertook the surveys on the ground, it was the Danish Navy which generously co-operated by lending a seaplane. As soon as the seaplane was assured for the expedition, the recognized aim of the surveying party could be to map the entire land features between the coast and the inland-ice. With the help of air-photography this task could be faced without dismay.

Nevertheless the actual methods to be used and the routine to be adopted had to be worked out step by step in the field. In this account it is mainly the final procedure which will be described; the mistakes, the difficulties, and the disappointments will be disregarded. The justification however for setting out in the *Geographical Journal* the procedure eventually developed lies in the fact that in its use no more elaborate or laborious field-work is required of the ground-party than that which would have to be undertaken on any normal rapid coastal survey. Where the technique has been successful in the field it has been in no small part due to the precision, rapidity, and convenience of the modern eye-piece-reading theodolite.

Photographic survey

One of the principal advantages of a photographic survey is that most of the work of map-making is deferred until such time as the material can be worked up at convenience. This is patently a matter of great significance to an exploratory expedition working on a coast which is only accessible for the brief space of three months in the summer. But, if the full worth of the photographs is to be extracted, a high degree of precision is demanded throughout

the chain of field operations. Not only must the photographs themselves be of good quality, arranged in properly related series, but the system of points fixed on the ground as control must lie in a very open network that is at once more exact and more widely cast than that usually required by the exploratory surveyor.

Flying and air-photography

Flying and air-photography may well be considered first. In the field there is little need for co-operation between air and ground parties provided the former are accustomed to strip-flying and have sufficient understanding of the general requirements of survey-photography to be able to act on their own initiative in the laying out of routes, etc. It is however not proposed to go into the intricacies of procedure in flying for survey work. This is most ably described in the book of the Mount Everest Flight.[1] Although the conditions at 13,000 feet in the Arctic are less severe than those encountered during the Mount Everest flights, most of the precautions and much of the test-routine for electrically operated cameras there described would be applicable to any survey flight.

In deciding what type of air-photograph should be made in Greenland the floats of the seaplanes were a decisive factor. For even had it been thought desirable to make vertical photographs or obliques steeply inclined to the horizontal, the obstacle of the floats would have made such photography impossible. It was in fact a piece of good fortune that when the camera was mounted in the floor of the fuselage there was just space enough between the floats and the planes to give an uninterrupted view abeam. When the whole field of view of the camera was employed and the machine flying level the inclination of the camera-axis was about 20° downwards from the horizontal.

The photographs made were of two types, of which the first, and the most important, comprised the obliques made in pairs for stereoscopic use at right angles to the line of flight. The interval between successive exposures was alternately. 2 and 6 km. The second type of photograph consisted of the so-called "tail-pictures," or photographs taken astern along the line of flight. These were exposed while flying along fjords and valleys, particularly those lying parallel to the coast and therefore imperfectly seen on the photographs from the normal routes. Their use is thus primarily to assist in completing the drawing of "blind-spots." A coast-line can be plotted mechanically from such photographs under certain conditions of control, but comparatively little is obtained in this way. It is well to remember that if the coast is much indented a disproportionate amount of flying time may be spent in making these "tail-pictures," whose significance, since they are seldom used instrumentally, is secondary.

The photographs were developed on the spot in both years, the mother-ship being fully equipped with dark-room and specialized personnel. But the superior results obtained in 1933 were probably due to the choice of a very satisfactory panchromatic film (Agfa Aeropan).

The routes parallel to the coast were laid out on the assumption that from good photographs plotting should be possible at distances between four and

[1] 'First over Everest.' By Air-Commodore Fellowes and others. London 1933.

thirty times the length of the base, *i.e.* between 8 and 60 km. from the photo-route. The first route ran 15 km. seawards from the coast and successive parallel routes were placed inland at about 40-km. intervals. Sufficient routes had to be flown to cover the land completely between the coast and the inland-ice, sometimes as many as four routes being necessary. The coasts of big fjords such as Sermilik or Kangerdlugssuak were photographed from routes parallel to the fjords themselves. Such routes were of great value since they gave stereoscopic pictures from both sides of a line running inland; the importance of these photographs was first realized during the working out of the material and will be discussed later.

Ground survey

(*a*) *The work of* 1932.—The procedure employed by the ground-surveyors in 1933 came into being through the mingling of the experience gained in 1932 by the two expeditions respectively under Dr. Knud Rasmussen's and Captain Ejnar Mikkelsen's leadership. Of these only the first was working in conjunction with air survey: that any part of the districts surveyed by Captain Ejnar Mikkelsen's expedition should in 1933 be photographed from the air by the continuation of Dr. Knud Rasmussen's expedition was unknown at the time the former expedition was in the field.

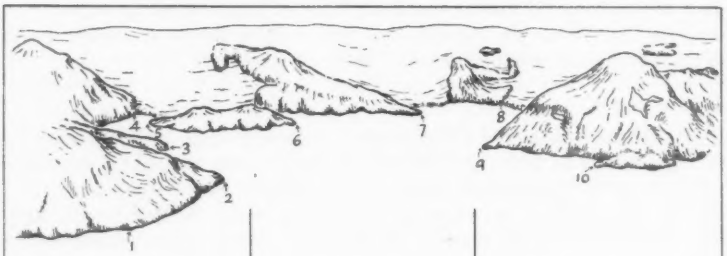
Dr. Knud Rasmussen's party of 1932 was in charge of an experienced surveyor, Captain Gabel-Jørgensen, who had for many years previously carried out triangulation in West Greenland. He was assisted by three naval officers, none of whom were trained surveyors. In such circumstances originality of technique hardly came into question. The method followed was to develop a triangulation conventionally from a short tape-measured base. Such a framework would be extended in each direction until it made contact with a similar triangulation extended from the adjacent base. Seven such systems were extended continuously over 250 miles of coast. The position of the tape-base stations was determined astronomically with as much thoroughness as the circumstances would allow, one of the officers being detailed to specialize in astronomical work. The triangulation stations were high and well placed and as many mountains and conspicuous points as possible were intersected from them; in addition all visible coast-line was sketched and as far as possible fixed by means of depression-angles to suitable points. This survey of coast-line rather than coast-points was undertaken when it became clear to the party in the field that detail such as a cape or island which seemed very conspicuous from a trigonometrical station might well be impossible to identify on an air-photograph. Only by fixing the entire coast-line could one obtain identifiable points with certainty.

This procedure had certain advantages. A regular triangulation is the surest ground-work to any survey. Computation is simple and gives in itself a check on the accuracy of the work. Further, the fixed coast-line implies that a preliminary map can be prepared before the air-photographs have been plotted. Moreover in the event of complete breakdown of air-photography the mere fact that so many stations have been occupied would enable some kind of a map to be drawn, assuming that good field-sketches were available. But this type of survey is characterized by the great labour of occupying a

large number of stations, many of which may lie at a considerable height; as well as by the difficulty of identifying from different stations the same mountain-top. Since it is precisely such mountain-tops which make the most valuable control of all, the second disadvantage is serious.

Survey of a fjord by depression angles from a single fixed point

10.8.1933 *Station* 7911 *Height* 424 *m.*



1	6410 *m.*	185° 32′	88° 05′ 46″
			3 48 24
2	8030	198 11	88 28 36
			3 02 44
3	12840	195 02	89 02 00
			1 55 56

The observations booked are the horizontal bearings to minutes of arc (Col. 2), and the reading on one face of the vertical circle which is figured so that the sum of the readings on the two faces is the vertical angle (Col. 3). The difference of the reading from 90° must therefore be multiplied by 2 and corrected for zero error (in this case 4″) to give the angle of depression, which is written into the angle book below the observed angle. From the height above sea of the observation station and the angle of depression the distances in metres are calculated by slide rule and entered in the first column, following the number of the point shown in the sketch.

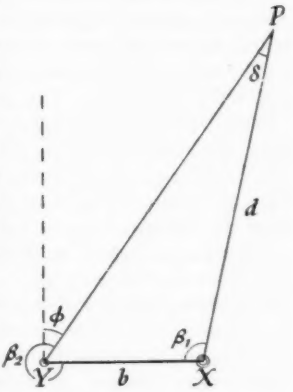
The group at work on Captain Ejnar Mikkelsen's expedition had meanwhile been mainly occupied with a terrestrial photogrammetric survey. This had been undertaken as the most suitable way of getting a precise map to be used as the basis of a geological investigation or a programme of colonization. A description of the methods used and the results obtained has already been published.[1] Here it is made clear how much use was made of the so-called base-method, or long-base range-finding technique as it might be named.

[1] Spender, "Map-Making during the Expedition," *Medd. om Grönl.*, vol. 104, no. 2 (1934).

(*b*) *The base method.*[1]—By means of a modern rapid-reading precision theodolite the length of a base-line between two instrument tripods can be measured optically with accuracy and speed. Direct measurement of the angle subtended at one end of the base by a subtense-bar set up at the other suffices for bases up to about 250 m. in length; for longer bases a shorter optically determined auxiliary base is desirable.

The light, wind, and conditions of visibility will decide how nearly this length of 250 m. may be approached. In measuring the angle subtended by the bar from the farther end of the base at least four sets of readings should be taken, the lower circle of the theodolite being shifted slightly between each pair. At 250 m. the angle subtended by the bar is about $27'1_2'$; an error of 2″ gives an error of about 0·3 m. in the length of the base, or a scale error of about 1/833, *i.e.* at a distance of 12·5 km. the error in the range of a point otherwise accurately determined from the base would be about 5 m. The results of a very great number of base measurements indicate that the subtense-bar can be observed at distances up to 250 m., and sometimes greater, with an accuracy approaching the limiting accuracy of observation with the theodolite used,[2] *i.e.* in the case of the Wild "Universal" that of a second of arc.

The base commands an area in which not only the direction but also the range of defined points may be determined. If circumstances are favourable, one end of the base may be a triangulation station and the distances may be calculated from that point; where the principal station is less favourably situated it may be necessary to lay out an eccentric base. The connection to the main station is however easily made with the subtense-bar; often in such cases the connecting leg may be used as the auxiliary base for a better determination of the length of the main base. At an important station the main base will command points to both sides; perhaps there will also be a short base for the survey of local features, and this also can often be used as an auxiliary base.



Any point visible from both end-stations may be defined in relation to the base by three angles, viz. the obliquity ϕ, the parallax δ, and the vertical angle α. The angle ϕ is not directly measured in the field and may appear at first sight to be somewhat arbitrarily chosen. It is the divergence of the sighting rays from the normal to the base and its cosine is the degree to which the effective length of the base is reduced. The plan shows ϕ and δ, and also makes clear the relation $d=b\cos\phi/\sin\delta$. Note that the obliquity is referred to the secondary end-station. The vertical angle α need only be measured from the primary end-station and is used in the

[1] *Cf.* Lieut.-Col. P. F. Jensen, "Om Opmaaling i mindre Maalestokke." *Meddelelse* No. 6. Geodetic Institute. Copenhagen, 1935.

[2] *Cf.* F. Ackerl. "Entfernungsmessungen mit der Wildschen Invar-Basislatte." *Zeitschr. f. Instrumentenkunde*, vol. 52, 1932.

expression $h = d \tan \alpha$, where h is the difference in height and d the distance of the point from the main station. Where the points are situated at angles less than 45° left and right from the normal to the base, *i.e.* where the obliquities are less than 45°, the parallax δ is comparatively large up to considerable distances. For instance at fifty times the length of the base it amounts to 1° 09′ for points on the base normal; and 0° 48½′ for points at the extreme obliquity (45° is the limit used in practice). The parallax is obtained as the excess over 180° of the difference between the two angles β_1 and β_2 which are measured in the field.

The accuracy with which these angles may be measured is not so much dependant on the surveyor or his theodolite as upon the point itself. To meet the criticism that these angles of intersection are ridiculously small we must first have an idea of the error in the determination of the parallactic angle δ which would produce an appreciable error, say ½ mm., in a map at 1 : 200,000.[1] In a typical case with a base 250 m. long the distance of a point 50 base lengths away is 12·5 km. At this distance the angle of parallax must be known within 35″ to give a position of ±100 m. Now the base end-stations are carefully set up tripods which remain in position throughout the working of the station. The theodolite is automatically accurately centred at each end and is in each case orientated to an equally accurately centred sighting-pin at the opposite station. Instrumentally speaking therefore the accuracy desired should be very easily attained. It is the point itself which has to be carefully chosen. For certainty there is nothing better than a stone in the middle of a snow-patch. Occasionally a peak will have a well-enough defined pinnacle or outstanding feature; but there is always a risk that even an experienced surveyor can take a knife-edged ridge seen end-on to be a pinnacle, only to discover the mistake at the second station. Before the surveyor has experience in the choice of objects to sight to, he must be prepared for about one in ten of his points to be erroneously determined.

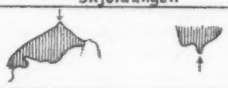
The successful application of the method is a matter of routine, rapid reading, and good booking. Not only has every point sighted to be sighted twice, but the base must be reconnoitred and laid out, all of which takes valuable time on a difficult station. The figure shows the method of booking which was finally evolved. It is seen to comprise five columns. To explain the way these are occupied it is necessary to refer to the actual operations at the station. First the tripods are erected at the base end-station; the theodolite is set up at the one and sighted to the centred pin on the other. The lower circle is then so set that the reading is 0° 0′ 0″, or only a few seconds from it. The points chosen as suitable for observation are now sketched or otherwise described in the first column. It is best to make a little sketch of the mountain on which the point lies as seen with the naked eye, indicating with an arrow the point's approximate position. A drawing is then made of the details seen in the telescope, so that precisely the same object may be picked up again from the other base end-station. The second sketch is of course drawn inverted,

[1] A more analytic treatment of the fine intersection will be found in R. Graf, Flums: "Fehlertheorie des Wildschen Autographen." Schweiz. *Zeitschr. für Vermessungswesen und Kulturtechnik*, 1928, Heft 11. See also Richard Finsterwalder, "Grenzen und Möglichkeiten der terrestrischen Photogrammetrie." Sonderdruck Jahrg. 1930, *Allgem. Verm. Nachrichten*, Liebenwerda, Saxony.

exactly as seen in the telescope. The next two columns contain the horizontal angles to the point, in column 2 the angle from the primary station, in column 3 that from the secondary station. (The primary station is that selected as pole from which the distances will be calculated.) Either end of the base may be the pole and there is no restriction as to which should first be occupied. But naturally enough every attempt will be made to use the central triangulation station as centre for the computation of distances.[1]

Survey by Short Base Method

23 . 9 . 1933 *Station* 7770 *Base* 241.3 *m.* *Height* 100 *m.*

1	2	3	4	5
High mountain on Skjoldungen	47° 29′ 42″	228° 27′ 21″ 0 57 39	91° 43′ 46″ +3 27 41 11 784	12980 895
	64 30 57	246 25 25 1 54 28	92 21 42 +4 43 33 4 803	8020 907
7756 Foot of cairn	102 25 05	285 22 36 2 57 31	92 29 36 +4 59 21 2 475	5440 577
Stone breaking the surface	314 30 37 3 29 00	131 01 37	89 12 04 − 1 35 43 1 100	3610 0

The second column contains the horizontal angle at X between Y and the object; the third the horizontal angle at Y between X and the object; below one of which the observer writes in the second minus the first minus 180°, which is the angle δ subtended by the base at the distant object. (See Appendix I.) The fourth column contains the half vertical angle observed on one face, the deduced vertical angle corrected for the zero error (in this case 11″), the correction for refraction and curvature, and the quantity $h=d$ tan (vertical angle) calculated by slide rule. The fifth column contains the distance d calculated from $d=b \cos\phi/\sin\delta$; and the sum of H, E—R, and h, which is the height above sea. In the present example the height H of the station has been found from a depression angle in the fourth observation. (See also Appendix I.)

(*c*) *The work of* 1933.—In 1933 the two survey groups of 1932 joined forces under the leadership of Captain Gabel-Jørgensen. It was thus possible to draw from the experience of two different types of survey. Our final ideal procedure, though it was not always possible to carry it out fully, was a combination of the methods of both parties.

The first result of this combination was that the triangulation units built up from steel-tape-measured bases were given up. But the principle of triangulation was respected by paying more attention to the connections between stations using the optical base method than had been given to the matter by the party in Kangerdlugssuak in 1932. It is not entirely satisfactory

[1] For the determination of the range of the object, see Appendix I.

to separate the stations so far apart that their mutual positions can only be found by uncontrolled observations to a single conspicuous point. An approximation to this technique was indeed forced on the expedition of 1933 when ice and travelling conditions forbade any other. But it was only for a short stretch of coast-line; otherwise stations were higher, better situated, and so far as possible arranged as part of a network.

Another major alteration was that the astronomical determinations of position, instead of being rather stately affairs conducted at the few measured base-stations at sea-level, became a matter of routine to be carried out at most stations, insofar as weather allowed it. Further, it became the rule that a sun azimuth should be taken from every station unless extreme circumstances forbade it. Altogether thirty stations were completely determined in latitude and longitude; while at a further twenty-six stations azimuth observations alone were made. In 1933 ninety-four main stations were occupied and a network built up whose scale and azimuth were continuously determined.

The great advantage of the base method is that the reiterated problem of the identity of mountains seen from different stations occupies very much less of the surveyors' time and attention. Questions of identity are settled without further trouble by the measurement of range and height. Even mountains at extreme distances can be approximately determined, and in this way intersections are obtained which would otherwise hardly have been possible.

(*d*) *Daily routine*.—In 1933 the four surveyors, all of them of at least one year's experience in Greenland, were divided into two groups, each of which had its own motor-boat. The two boats worked independently on different parts of the coast and communication was kept up as regularly as possible by wireless.

During the fine weather of the summer, as one working day followed the other, a routine developed which was afterwards kept to as closely as possible. The survey motor-boat would find an anchorage near the prospected station for next day's work. Between 3 and 4 a.m. the party would be called, and after checking the chronometers and eating a hasty meal of porridge the climb would be started. The two surveyors generally went together to the same station, assisted by two or sometimes three Greenlanders. The object was to reach the principal station before 7 a.m. (local time). The principal station would always be at the highest point. After arriving at the summit one surveyor would set up his tripod, using his rock-boring equipment if necessary to ensure a good footing. While he took a round of angles to such of the neighbouring points as were recognizable, his companion reconnoitred for a base or bases. By the time the latter returned after half an hour or so, the theodolite had settled down and was ready for the morning longitude observation. In the course of ten to fifteen minutes three sets of four sights of the sun could be made. But care was taken that the parasol shaded the theodolite at all times except during the actual observation of the sun. Another seven minutes sufficed for two further sets for the azimuth observation.

The two extra tripods would now be laid out at the end-station of the base or bases. The first surveyor referred their position to the general network and his station, observing to the subtense-bar should that have been indicated and the lighting suitable. If one of the bases were extended from the principal

The survey motor-boats in the ice of the east coast, July 1933

Surveyors at a station above the fjord chosen by Watkins as a base in 1930–31

Cairn building

The finished cairn

Cairn building

The finished cairn

station he would begin to note the points that would be fixed. By the time his assistant had established the bases the angles could be dictated direct into the angle-book. If photographs were to be made from the base with a photo-theodolite it was often convenient to expose them as soon as the round of angles was complete. The party then moved to the other end-station, leaving a centred pin on the first tripod. The photographs were usually made at once at the second station, so that light conditions were as nearly as possible similar for both photographs of the stereo-pairs.

All the points observed at the first station must be picked up and re-observed from the second. These observations should be finished at least in time to occupy the principal station for the circum-meridian observation for latitude. It is a matter of experience to fit in the various movements so that a minimum of walking or clambering to and fro is necessary. There may be several bases and there may be eccentric stations for coastal survey by depression angles; the subtense-bar may have to be erected in several positions and the lighting may condition an awkward sequence in the photography. Where a man has to work such a station single-handed in the sense of having no expert help he will find the actual physical labour at his station much more exhausting than the, say, 2000-foot climb he has had to get there. There is rarely a moment's pause in the work, even when two men are at the station; not until the observations are finished can there be a breathing-space; and that will last no longer than the Greenlanders take to build a 7-foot cairn from the stones leisurely collected while the theodolite was in use.

Cairns

Cairns are laborious to build, and it is often unwillingly that time and energy are spared for their erection. But if a little study is given to the matter—principally in remembering that a cairn is not a heap of stones, but something to be built carefully, like the walls on the fells in North England—a cairn 7 feet high can be built by three willing men in twenty minutes, assuming that the stones have been collected beforehand. The first principle is to begin with an accurate ring of stones, in this case properly centred round the copper bolt which has marked the station. One must now build layer over layer, from the outside towards the middle, sizing the stones so that at the end of each layer there is a slight slope downwards from the circumference towards the centre. The stones in the middle should be smaller than those outside, but if the centre is filled with rubble the cairn will collapse before long.

Cairns are not only invaluable to the surveyor himself—for without cairns his triangulation will not be much good, moreover they are excellent sighting objects for the base method—but they are as marks much appreciated by mariners. They give the groundwork for any sounding that may be done later; and should there be any question of a re-survey it would hardly be an exaggeration to say that the work of the re-survey would be halved if the necessary cairns had already been conscientiously built.

Terrestrial Photography

The base-line of the method here described is often identical with the base that would be chosen to photograph the same tract of country photogrammetrically. Consequently the question arose whether or not to make terrestrial

stereo-pairs from the range-finding base. It was clear that to have the photographs, particularly of the very fine pictorial quality obtained on the slow "process" emulsion, could only be an advantage. Against the use of a photo-theodolite weighed such considerations as the extra load (slightly less than a filled rucksack), the risk to a valuable instrument, the extra time and labour at the station and the cost of the film. The advantages which seemed significant could be placed in three categories. First that much could be mapped from the terrestrial photographs alone should the air-photographs through some unforeseen misfortune fail. (Although in the course of the employment of three aeroplanes in two summers in Greenland no accident whatever befell the Danish flying crews, the possibility of disablement of an aeroplane cannot, unfortunately, be left completely out of account.) The second line of reasoning which led to the use of terrestrial photogrammetry was the fear lest among the low, rounded forms of the land south of Angmagssalik it should be impossible to find any point at all which, fixed from the ground, could be re-identified from the air. The third reason was that the photographs gave the best description of the actual points surveyed. The identification in an air-photograph of some particular feature seen from the ground is often only possible by means of apparently unimportant detail like snow-patches, which could not have been adequately sketched in the field.

As things eventually turned out it was the third reason which showed itself to be the most important. The great value of these photographs has indeed well repaid the time spent in taking them and the trouble of carrying the instrument up the mountains. Every point surveyed, whether snow-patch or mountain-top, can be found at once on the terrestrial photographs by setting off its coordinates from the angles in the field journal. Such a point can now be seen in relief in the stereogram formed by the terrestrial photographs; it is then an easy matter to re-identify it in the relief model formed from two adjacent air-photographs covering the same terrain. This photographic record renders the survey in a more permanent form, less dependent on the memory of the surveyor. The enormous stretches covered by air-survey and the protracted time spent in working up the results make such considerations doubly important.

Working up the results

(*a*) *Construction of the network.*—The first office work undertaken after the return of the expedition was the development and cataloguing of the photographs and the computation of the astronomical observations. In cases where it may have been impossible to observe for both longitude and latitude, a start often had to be made with the construction of the triangulation network, since in high latitudes a small error in the assumed position causes fairly large errors in the final value. Parts of the triangulation were calculated, especially where the data were redundant, *e.g.* triangles in which three angles and more than one side had been measured. As soon as the mean values were settled, construction was proceeded with graphically, using transparent sheets of paper on which a divided circle had been printed. The sights from each station were collected on such a protractor. The assembly of the stations is best carried out over a suitable projection, otherwise advantage cannot be

taken of the azimuths. An arbitrary start can be made from an astronomically determined position; the construction is then continued for a while, orientating each group of sights according to azimuth, but otherwise without reference to other astronomical positions. Frequently objects surveyed from successive stations will reveal themselves as identical, thereby further stiffening the network. After a suitable distance has been covered, a tracing of the network may be laid over the astronomically determined positions of the key-stations. Discrepancies will appear which must be examined for errors either in the construction of the network or in the computation of the astronomical positions. A slight adjustment of the triangulation may be necessary. The final position for the network is found by trial.

It is typical of work in Greenland that when observations are made to the sun the discrepancies at the astronomically determined positions are of an order rather larger than the internal evidence of the observations would suggest. In other words, the discrepancies are generally greater than the mean error of the mean value of the observation. The matter is under investigation.

(*b*) *Plotting from the air-photographs*

The total content of the ground-survey is a number of stations, intersected points, and spot-heights, with here and there coast-line, islands, skerries, glaciers, and similar detail which could be useful as control. This detail was plotted at the Geodetic Institute on the scale of 1 : 200,000 on paper stretched over large boards about 3×4 feet in size and extending over two parallels of latitude. As soon as the air-photographs are marked with all the detail shown on the map at that stage, the material is in a suitable state to be handled at the plotting machine.

The general lines of the procedure at the Aerokartograf have been worked out by the Photogrammetric Section of the Geodetic Institute. To begin with, a stereoscopic pair of air-photographs is set in the machine and the mutual orientation taken as far as possible. The first approximation to scale is calculated from the automatically photographed time-interval between the two exposures. With oblique photographs the final adjustments of the convergence cannot be quite perfect from the mutual orientation alone; a small error in this element causes large displacements of points in the background. But a rough setting is made from the distance between foreground and background points. The stereoscopic model is at this stage approximately correct and points whose position is known, *i.e.* control points in the foreground and background, may be laid out from the model on tracing-paper; after which directions through the points are drawn in from the projection of one of the camera stations. The result is a bundle of rays from the point of exposure which can be fitted over the true, mapped positions of the control points much as a station-pointer is used to give a resection at sea. The displacements of the positions of the control points as plotted from the model from their proper positions will indicate how the remaining errors in scale, convergence, and obliquity should be corrected.

It may happen that for one reason or another the control available is insufficient to fix a stereogram. As a case in point the territory between Kangerdlugssuak and the Blosseville coast may be considered. Here the coast runs more

or less east and west. At the western end lay the system built up in Kangerdlugssuak for the terrestrial photogrammetric survey of 1932. At the eastern end there was a group of points fixed during the traverse of the coast in the same year. Between them stretched a tract without survey which was photographed by the Seventh Thule Expedition in 1933. However, Kangerdlugssuak was fortunately one of those large fjords in which photo-routes had been flown along the fjord and at right angles to the coast. Through great good fortune a group of mountains with a conspicuous peak 2500 m. high was to be seen in the background of the photographs exposed towards the east. It was possible to use these points as control, and to plot out of the resulting stereogram points lying in the intermediate gap for use later in connection with the coastal photographs.

A more general case of lack of control occurs when the ground-survey has only given a strip of points along the coast very thin in comparison with the depth of land to be mapped. A fjord with a corresponding cross-route may enable a kind of triangulation to be carried out. Photographs on the coastal route can be fairly well adjusted for scale but are uncertain in convergence without background points at a suitable distance inland. Nevertheless the directions obtained from these approximately adjusted stereograms are correct and lines of direction can be drawn to conspicuous points in the background. If now the procedure can be repeated for photographs from a fjord-route at right angles to the coastal route and covering the same terrain, it may be possible to obtain another series of position lines for the same points, thus fixing them by intersection. This method was found to be very satisfactory in the Mount Forel region.

The cross-route plays therefore in certain circumstances an important rôle; future surveys will probably insert them regularly. Where a coast is convex towards the sea an effect somewhat similar comes into play. As the aeroplane follows the trend of the coast the camera is swung so that the same background points are continually re-photographed. By setting stereograms from each end of the curve before plotting is begun, these background points may be intersected and used thenceforth throughout the run of the work. This is a compensation for the difficulties and annoyances of carrying a triangulation forward along a coast curved towards the sea.

Plotting goes forward at about the rate of one stereogram per day. When eventually all the suitable photographs have been plotted, some gaps and blind spots remain which have to be filled in. Moreover the contours must be checked in some detail by re-examination of all the available photo-material; irregularities of plotting must be distinguished from true features of the terrain. The tail-pictures can be of great use at this stage, though inevitably some of the filling out will depend on the topographer's knowledge of mountain formations and on his skill in making use of the slight indications that may be present.

In Copenhagen plotting was done on the drawing-celluloid called "Kodatrace." The finished drawing, corresponding to the inked-up sheet of the field surveyor, was traced through on to another such sheet of celluloid, correcting and filling in being done at the same time. This second sheet, when completed, is the final stage of the map as far as the present consideration is concerned.

APPENDIX I: THE CALCULATION OF DISTANCE AND HEIGHT

In fig. p. 323, showing the method of booking at a "base-method" station, there are two styles of figures. The italics are those entered during the working out of the observations. The parallactic angle δ, the excess of the difference between the two angles in columns 2 and 3 above 180°, will be set in one or the other column, according as to which of the two angles exceeds 180°. The obliquity ϕ is the arithmetical difference between β_2 entered in column 3 and 270° or 90°, according as β_2 is greater or less than 180°. If the base-length be already worked out from the angle to the subtense-bar, d can now be calculated from the formula $d = b \cos \phi / \sin \delta$.

This is best done on a 50-cm. slide-rule divided along the fixed scales for distance and along the sliding scale for the angular functions, sine on the face and tangent on the reverse. Such slide-rules have been specially made for the Geodetic Institute in Copenhagen by the firm Dennert and Pape, of Altona. They give also the correction E—R for curvature and refraction, which may be read off as soon as d is determined. The whole operation takes no more than a few instants and d can be entered as the upper of the two figures in column 5.

The circle readings of the angles of elevation and depression in column 4 have first to be converted into true angles. In the example given the angles are measured with a Wild "Universal" theodolite in the first, or face-right, position. The second figure in column 4 is the true angle; below it is the correction in metres for curvature and refraction. The fourth term, obtained from the slide-rule after reversing the scale, is $d \tan \alpha$, the difference of height h between the observer and the point observed. If this point is at sea-level, it will give the value of H, the height of the station. For all other points the algebraic sum of h and H will give the height of the point concerned, which height is then entered as the lower of the two figures in column 5.

APPENDIX II: LIST OF EQUIPMENT REQUIRED BY A SINGLE PARTY ENGAGED IN SURVEY BY THE BASE METHOD

1 Wild Universal theodolite, 4 tripods equipped with sighting pins, 1 subtense-bar, 2 chronometer watches, 2 barometers, 2 thermometers, field-glasses (×8), field journals, bamboo sticks, flags, rock-boring equipment, copperbolts, parasol, and perhaps photo-theodolite.

PLEISTOCENE GLACIATION IN THE ANDES OF COLOMBIA

PROFESSOR A. P. COLEMAN, F.R.S.

COMPARATIVELY little is on record in regard to Pleistocene glaciation in the Andes of Colombia, though a Pleistocene depression of the snow-line of 3000 or 4000 feet has been proved in the mountains of Ecuador and the countries to the south[1]; and it seemed worth while to make a brief study of glacial features in the northern part of the Andes to complete the evidence as to conditions in the Cordillera during the Ice Age. With this in view a visit was made to the region of Bogotá and to that of the Nevado de Cocuy in the winter of 1934, and another to the region of Santa Marta, at the north end of the Andes of Colombia, in the past winter.

Bogotá, which is on a tableland 8600 feet above the sea, may be reached by a voyage of 600 miles up the Magdalena River to Girardot, and a climb of more than 7000 feet by rail; or better, by air, which saves a week of slow and uncomfortable travel. A short distance east and south of the city the Andes rise to a height of more than 12,000 feet, which should be sufficient to provide evidence of Pleistocene ice-work. Through the courtesy of the Government of Colombia, Dr. Heinrich Hubach, of the Department of Industries, was instructed to accompany me, and his knowledge of the country and its geology was of the greatest assistance in choosing suitable points for study and in organizing the excursions.

Close to the city of Bogotá on the lower flank of Monserrate bouldery deposits suggesting ice-work occur at about 9000 feet; but no striated stones were found and their origin is doubtful. If glacial, they must date from early in the Peistocene. These boulder beds have been cut through to bedrock by the small Rio San Francisco, flowing between Monserrate and Mount Guadalupe. A short excursion south of the city, on the road into the mountains towards Ubaque, showed probable till at 10,290 feet, and more certain morainic features including some striated stones, at 11,250 feet. These moraines were subdued and ancient looking. A longer excursion towards the south-east, by rail to the village of Usme, and then on horseback up the valleys of Chisaca River and its tributary, Corubital, brought more definite results. At 10,500 feet a bouldery plain above the main river seemed to be glacial and at 11,230 feet, in the valley of the tributary, undoubted boulder clay with striated stones was well displayed on the river bank. As we ascended, the eucalyptus plantations seen everywhere on the tableland of Bogotá came to an end, and native shrubs and small trees, some in handsome bloom, grew on the mountain-side. It was surprising to find a small variety of bamboo at the higher levels, and the foxglove, widely spread in lower regions, was here replaced by blue lupins, while in small fields on the slopes white clover was spreading. These foxgloves and clover were probably introduced from Europe.

We halted for the night in a typical farmstead of three houses at 11,230

[1] Hans Meyer, 'In den Hoch-Anden von Ecuador,' pp. 460–467.

feet, on a narrow shelf along the river, with mountain slopes rising steeply on one side. The houses were walled with cane and earth and roofed with overhanging thatch. One, used for cooking, with a fire between stones in the middle of the earthen floor, had no window or chimney, and the smoke escaped round the eaves and through the open doorway. Another, which served as sleeping quarters, had a door which was closed at night. The only visible cultivation was that of potatoes, and little heaps of brush were burning on the hill-side to prepare for the next planting. The food of the household was potato stew, but cattle were pastured on the mountain-side and *cafe con leche* was prepared for us. The following morning we rode up the valley, guided by the owner of the farm, to the *paramo*, or moorland, at 12,000 feet where ponds and lakes dammed by moraines occurred in a boggy valley with steep mountain peaks on each side. Rounded *moutonnées* rocks rose above the marshy vegetation, and the whole impression was of recent glaciation, corresponding to the Wisconsin ice advance of North America. Unfortunately the day was foggy and rainy so that pictures could not be taken.

Dr. Hubach states that the region dotted with lakes covers an area 40 kilometres long by 30 wide, so that there must have been a respectable ice-cap in late Pleistocene times in lat. 4° 20′ N. In the Corubital region there were evidently at least two Pleistocene ice invasions: an older one represented by the subdued morainic forms at about 11,250 feet, and a much younger and less extensive one on the *paramo* at 12,000 feet. Since returning an account of very similar glacial features at Laguna de los Patos and Laguna del Verjon has been found in writings by Otto Stutzer.[1] I have not been able to find these names on the only available maps, but it may be that his observations apply to the region just described. Stutzer does not mention the more ancient moraines at lower levels.

Our most important excursion was by bus to Soata, 320 kilometres north-east of Bogotá, and then on horseback to Cocuy and the Nevado de Cocuy. The motor road north-east from Bogotá traverses first the *sabana*, or table-land, and then follows a winding route with many steep ascents and descents among the mountains to Soata. The mountain portion of the road has fine scenery and at one point crosses a *paramo* at 11,700 feet. This was apparently glaciated, though no stop was made to examine it carefully. Soata was the last town on our route reached by rail or motor road. Beyond this we followed roads on which wheels could not be used; and it was interesting to find towns with thousands of inhabitants depending for all their transport on pack animals or burden-bearing men and women. There are hundreds of thousands of people without wheeled vehicles in the more mountainous parts of Colombia.

From Soata we made our further journey on horse or mule, including ascents and descents of thousands of feet over mountain ridges. Soata is at 6800 feet, and we crossed Chicamocha River at 4700 feet, before climbing to a *paramo* at 12,400 feet, passing from a semi-arid tropical valley with huge prickly pear, organ cacti, and plantations of bananas and sugar cane

[1] "Beiträge zur Geologie und Mineralogie von Kolumbien, V, Ueber Spuren einer diluvialen Vereisung im Gebirge bei Bogotá," *Neues Jahrbuch für Mineralogie*, LV Beilage Band, Abt. B, 1926, pp. 518–520.

to bare moorland above the last trees. From the *paramo* we could see the serrated white ridge of the Nevado de Cocuy, our destination, 25 or 30 kilometres to the north-east. A very rough and steep descent brought us to the small town of Cocuy at 9100 feet, and from there we rode about 20 kilometres to La Esperanza, a farm-house in the valley of Cueva River at 11,800 feet, in the midst of characteristic moraines. Two days were spent here, the first devoted to a journey up the valley to the Nevado and the second to the study of the moraines.

There was frost on the ground as we started from La Esperanza for the glacier, on fresh horses so as to give our spent animals a rest, but the sun became hot as we went on, since the latitude is about 6° 20′ N. There was little to suggest a trail after passing the tree-line, but the valley was open except for patches of the curious mountain plant, frailejon, whose round trunks, clothed with stiff blade-like leaves, may reach 10 or 15 feet in height. The last 2 or 3 kilometres were over heaps of bare quartzite boulders, here and there giving place to ice-smoothed bedrock. The edge of the glacier seemed stagnant and was not impressive. The surface was bare of snow, not badly crevassed, and had a gentle slope making excellent walking so far as I traversed it. The aneroid reading gave almost exactly 15,000 feet. There was no suggestion of the *nieve penitentes* described by climbers on glaciers farther south in the Andes.

Dr. Hubach went to the top of the Pan de Azucar, said to be 5100 metres high, and returned in about three hours, finding the climb not difficult. Bare cliffs rise above the snows of the upper slopes in places and a strange pillar of rock with vertical sides is called the Pulpito del Diablo; but in spite of its elevation the scenery is not as fine as that of much lower peaks in the Alps or the Canadian Rockies.

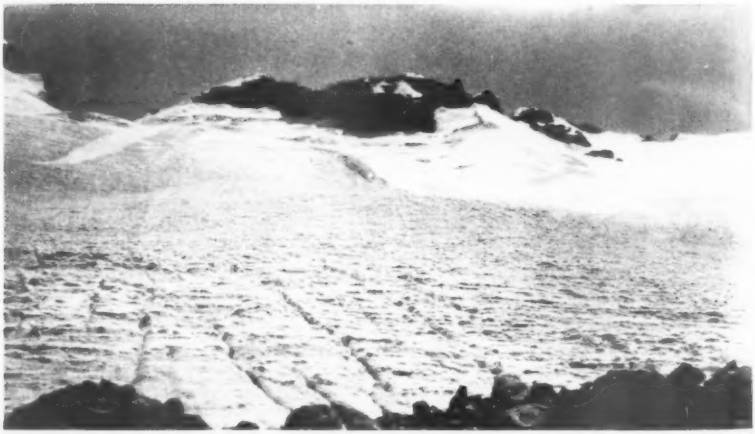
We were told at La Esperanza that the glacier has retreated 2 kilometres in the last five or six years, and the broad tract thus left bare is exceedingly rough, consisting mainly of sharp-edged blocks of quartzite, enclosing ponds but no vegetation. A little lower there are horse-shoe shaped moraines, and swampy areas with grasses and clumps of the frailejon bushes, representing some late Pleistocene stage of retreat. Still lower, moraines clothed with trees continue past the farm at 11,800 feet, with typical lateral and terminal forms and extend 3 kilometres beyond, reaching a level of 11,280 feet, where the river has cut cliffs showing boulder clay with striated stones. This wide band of well-preserved, but grass and tree covered, moraines is probably all of Wisconsin (Würm) age, and could probably be divided into stages of recession if studied more in detail. Farther down the river valley, but hundreds of feet below, more subdued land-forms suggesting an older glaciation could be seen, but lack of time and absence of roads prevented a closer examination. The glacial soils are stony but fertile, and crops of excellent potatoes are the chief support of the farmers, though barley and wheat are grown also, the latter threshed by driving horses round the floor on which the straw has been spread. Ploughing is done with a tree trunk having a downward projecting fork. As the climate is dry, irrigation is necessary, and in one place an irrigation ditch follows for hundreds of yards the ridge of a lateral moraine.

A glacial lake south of Bogotá

The tableland of Bogotá from the mountains behind the city

The Pulpito del Diablo, Nevado de Cocuy

A moraine near La Esperanza



A glacier on the Pan de Azucar in the Nevado de Cocuy

The Andes near Santa Marta

The Nevado de Cocuy is more than 300 miles from the northern end of the Andes, and it seemed desirable to see something of the mountains near the Caribbean Sea, so last winter a short visit was made to the Santa Marta region, on the Colombian coast east of the Magdalena River. It was found that the best approach to the high mountains was from Diboulla, 26 leagues to the east of Santa Marta. The sea voyage was covered in a dugout canoe propelled by an engine taken from an old motor car.

From Diboulla inland travel is over mountain trails, usually very poorly made, through dense forest in the hot lowlands and foothills, but at higher levels largely along bare mountain slopes. The route was winding, with very steep gradients, and could be followed only on horse or mule back, while transport was mainly by bulls. A night stop was made at the village of San Antonio, 11 leagues from Diboulla and 3450 feet above the sea. This is in an agricultural region with fields of sugar cane and bananas. Its inhabitants are greatly intermixed with negro blood, like those of Diboulla.

A second day's journey ended at San Miguel, at 6000 feet. This village is inhabited by Arawak Indians, apparently of unmixed descent, and proved very interesting, with well-built houses having walls of cane and earth surmounted by steep roofs of thatch. The guest house provided for travellers proved to be clean, roomy, and well kept, and the gardens supplied potatoes, yams, beans, and onions. They cultivate also cotton and the cocaine bush, whose leaves, with lime to set free the alkaloid, are in constant use. The cotton is spun and woven and made into clothing, and the community seemed almost independent of the outside world, except for cutting-tools of steel. The men, who were short and stocky, were dressed in white cotton, with bare feet and a head of bushy, unkempt hair. They kept cattle, pigs, and poultry, which must have been introduced from Europe, but otherwise seemed to retain the civilization of their ancestors, whose terraces for cultivation can be seen along the valley.

A third day's journey disclosed what seemed to be a moraine of scattered boulders widely spread at 8000 feet, and ended at 10,000 feet on a bouldery terrace that was distinctly morainic. It had been intended to go another day's journey up the valley to the edge of a *nevado*, but the collapse of a mule not far from San Antonio had seriously bruised my right leg, and it appeared unadvisable to follow the very rough trail farther inland. At 10,000 feet the terrace included a garden in which vegetables were growing, and also four small houses with conical roofs, while cattle were pasturing on the mountainsides. The air was bitterly cold at night, and it was a surprise to find the Indians going about with bare legs and feet.

The boulder deposits just mentioned seemed almost certainly glacial, though the final evidence, in the form of striated stones, was not found. The lower of the two supposed moraines, at 8000 feet, is below the level hitherto recorded for ice-work in the tropical Andes, so far as my reading goes; but the boulders extend for half a mile across a wide valley at that level, and I do not see how they can be accounted for otherwise.

In a previous journey I had seen Pleistocene boulder clay at 9000 feet, at Puente del Inca in Argentina, near the foot of Aconcagua, and also at about

12,000 feet near La Paz in Bolivia. Including the glacial features of Ecuador and Peru, described by Hans Meyer and referred to on an earlier page, the Andes have been shown to have proofs of Pleistocene glaciation from lat. 32° S. to lat. 11° N.; and a twofold glaciation has been described also in Patagonia. The whole Cordillera was twice glaciated down to at least 3000 or 4000 feet below the present glaciers, and these Pleistocene climatic changes must be taken into consideration by those who advocate the "Drift of Continents" as accounting for Ice Ages.

THE OROGRAPHY OF THE NORTH SEA BED

R. G. LEWIS

IN view of the fact, as now accepted, that at one time much, if not all, of the North Sea Bed stood above present sea-level, it may be of interest to examine its orography with the idea of discovering, if possible, in what channels the great rivers which now flow into this sea flowed then, what were the features of that drowned country, and what evidence of tectonic movements can be discovered. Any deductions are in the nature of things bound to be somewhat speculative, but it is submitted that there are differences in degree. In the case of rapidly shelving ground deductions may be so speculative that they have no value. Where large nearly flat plains the size of an English county are concerned, however, the sensitiveness of running water to changes of level will enable useful deductions to be drawn.

The accompanying map has been prepared by a simple method: the Admiralty Chart No. 2339 calls attention to a sounding much above or below the general level of an area by a line drawn round such figure. After this manner where, for instance, a sounding of 10 fathoms appears surrounded on all sides by figures of 11, a circle was drawn round the 10 and the next line, representing the succeeding contour, through the figures 11, and so on. In this manner, and by interpolating where adjoining soundings differ at all widely, the orography has been arrived at.

The chart marks the contours at 10, 20, 30, and 50 fathoms, and interpolated contours have been shaped with regard to them. Thus, although where the ground falls steeply between soundings there may be a local error, in an area of gentle relief the margin of error is small, as the contours were run at every fathom with constant regard to the obvious fall of the land. To avoid confusion the map shows only the contours at 5-fathom intervals. No attempt has been made to draw the contours on the steep Norwegian coast, nor in the deep passages among the Orkneys and Shetlands.

The most important southerly feature of the orography is the Dogger Bank *massif*, stretching at 20 fathoms from square D 10/11 to square F 9 (see Map): a large portion is at 15 fathoms and at the Lincolnshire end the ground rises to 9 or even 8 fathoms. The line of its axis continues that line running from Cornwall *via* the Cotswolds, Northampton Uplands, and Lincolnshire Wolds. Immediately south of its highest portion, at D 11, is a deep trench known to

fishermen as the Outer Silver Pit, which bottoms at 50 fathoms. This is one of the two channels by which, when the land stood at above the 20-fathom line, all the drainage must pass from the southern area shown on the map which did not escape southwards through the Strait of Dover. The other channel is shown to the east of the Dogger Bank, where the 25-fathom line makes a deep inlet.

On the north side of the Dogger Bank the ground falls rather steeply from 20 to 30 fathoms, and from here northwards the whole sea bed is suggestive of considerable tectonic disturbance. Circling Norway is the Norwegian Deep, which Jukes-Brown (1) considered to be the submerged end of a great river draining the Baltic plain. This deep, to which the ground falls suddenly, appears to be a synclinal fold that has raised an anticlinal fold on its margin running from D 5 through E 6 and F 7 to G 8.

On the British side the ground shelves rapidly to considerable depths.

South-east of the Dogger Bank, scattered on a peneplain at 20–25 fathoms, are a number of little hills, the soundings being remarkably uniform at 20 fathoms. Their disposition and the lie of the drainage give no reason to suppose that they are erosional features, while, on the other hand, their position along a line joining the limits of British and Danish ice action strongly suggests that they are moraines. Their even height may indicate planing off by wave action while within reach of that influence.

In the Jutland area—G and H 8 and 9—similar hills appear, and they are to be discovered in other places near the Dogger Bank. At some time what appears to be a moraine was dumped right across the Outer Silver Pit valley at C/D 11, and if this occurred before the ground east of the Dogger Bank extension had subsided, it would force all the water entering the southern area to escape by the Strait of Dover. (In this connection see (2) and (3).)

Soundings are occasionally met with showing elongated depressions of small width. These have been taken to be river valleys, of which the Outer Silver Pit is one (the reason for its east–west trend is obvious, it is circling the southern end of the Dogger Bank).

Leading away from the Wash at C 12 is a similar deep which slopes rapidly from 20 to 50 fathoms. Here must have been a large river carrying not only the Wash but the Humber drainage as well, on its way to join the first river as it issued from the Outer Silver Pit.

It has been widely held that the Rhine formerly flowed out through the Zuider Zee through a little deep just south of the 11/12 line, col. E, and into the Outer Silver Pit; but it seems a little invidious to continue to call the great northward-flowing river from this point by the name Rhine, and for the purposes of this paper it will be referred to as the Silver River.

In square D 12 there are traces of several, or perhaps stretches of one, river valley—if this is the nature of these deeps—leading up from the south-east to join the first two.

Leaving aside a deep off the north coast of Aberdeenshire and another near the Shetlands, the remaining group of deeps can be seen on the map at C 8. Gregory took them to be traces of the valley of the northward-flowing river that we have named the Silver River, and considered that the 50-fathom line on the Chart marks the "pre-glacial" coast-line.

The usual rectangular bay in the 50-fathom line is a little misleading. There is an exit channel—line C/D 7—known to fishermen as "The Gut" at 51 fathoms and the soundings of the bay vary from 59 to 51. The bay is only separated from the Gut or from D 6 by a low ridge at 48 fathoms, so that practically all the ground north of the rectangular bay is nearly flat and may have been affected by the anticlinal rise referred to as paralleling the Norwegian Deep. The topography suggests that formerly the Silver River flowed some 20 miles to the east of the Gut and was forced over westwards by the rise of that anticline.

Between the Dogger Bank and the present coast on the south-east is a large area some of which is at 20–25 fathoms and some at 25–30. On the east of this is an obvious way of escape for the Elbe, Weser, and Ems water, while a south-westerly extension of the upper reaches of this estuary looks as though at some period the waters of the Rhine joined it. However, disposed opposite the Zuider Zee is a catchment pool. The arrangement of the whole basin is such that it appears probable that at one time the basin overflowed through the Outer Silver Pit only and that later, or at another time, the eastern estuary was open.

Just north of the Gut is another catchment pool which also seems (when this area stood above sea-level) to have overflowed in various directions. There is a channel, on C/D 6, at 85 fathoms bottoming at 93, and an early direction of overflow appears to have been towards the indentation in the 80-fathom line at E 5. Another direction may have been through a sounding of 81 at D 5 to the southern end of the important estuary at C/D 3/2. A third direction may have been through a sounding of 80, B/C 5, and out between the Orkneys and Shetlands or to the west end of the great estuary already noticed.

The scarp at the north end of the Gut calls for comment. North of Aberdeenshire, A 7, the ground falls precipitously and, if the south Moray Firth coast was fault-determined, such east–west fault is probably connected with the Great Glen fault. The scarp may then be a fault scarp. It has been cut into by a river issuing at B 7 from the Forth–Tay direction, on the line of the Highland Boundary Fault, and at the Gut the Silver River ran in this channel long enough to make a deep incision. Further to the east the scarp has been obliterated by the anticlinal rise already mentioned.

To return now to the west-central area: a puzzling feature is the number of basins which bottom at 50–60 fathoms. The Gut leads out of one, but only at the 51-fathom level. There are two others, at B/C 8 and B 9/10. At C 9 there is a solitary sounding of 87 adjoining one of 53, and as to the course of the Silver River, Gregory (3) proposed to fix the course as from the Outer Silver Pit through these to deeps at C 8 and so to the Gut. This map however suggests that there has been continual short-circuiting as the central and eastern ground subsided. At the close of Pliocene times, according to Harmer (4), the estuary of the Rhine crossed Norfolk, and in it were laid down the Chillesford Beds; at a later time its course was probably from the Outer Silver Pit through the basin at B 9/10 to the estuary at B 8/7. This valley has been dammed by what is probably morainic material issuing from the Forth-Tay.

The first short-circuit may have been from the basin at B 9/10 through

that at B/C 8 to a little estuary at C 7. Further short-circuiting took the river north-eastwards from the B 9/10 basin and out, not through the Gut but, as already mentioned, through a channel more to the east. This is the course marked 1 in Fig. 1.

Further short-circuiting probably diverted the river through a new north–south channel at C 10/9, and at this time the Gut was probably in use and the northern exit numbered 2 in Fig. 1, and the Silver River therefore took a northerly course for 400 miles, plunging in mid-career over the scarp and reaching the ocean by a noble estuary 70 miles long by 10 wide. A further deflection, traceable to the influence of the anticlinal rise already mentioned, probably fixed the river's course as that numbered 3 in Fig. 1.

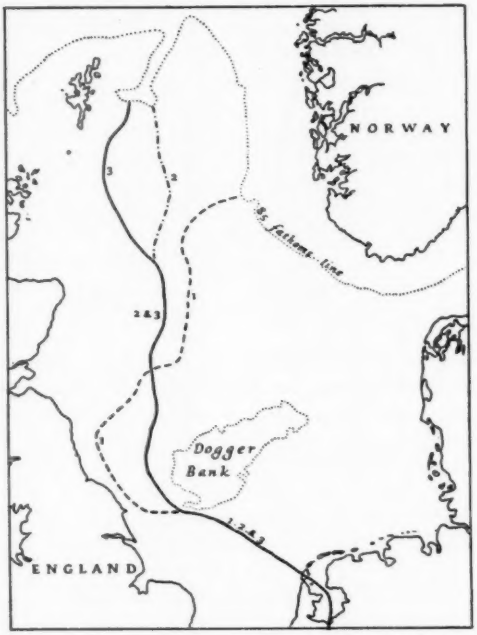


Fig. 1. Probable courses taken successively by the Silver River

It is when the levels of these traces of a great river's course are examined that tectonic disturbance of the area becomes apparent. The Outer Silver Pit and the Wash Channel bottom at 50 fathoms, and there are two deeps near this latter at 40 and 48. If we take the distance from the least of these, 40, to the 55-fathom line at the Gut, it is roughly 220 miles and the fall 90 feet, giving under 5 inches to the mile, which is poor compared with the Thames below Lechlade, which averages 20 inches per mile.

But north of these deeps there is no sounding approaching 130 fathoms until we pass the 100-fathom line, if we except the deep in A 3, though the basin just north of the Gut bottoms at 93 fathoms. On the east of the Silver River there is the anticlinal rise already referred to as paralleling the Norwegian Deep, but there is nothing to show that this is affecting the Silver River valley; and the levels indicate that the valley is affected by elevation centring at C 4 and 5 and depression centring at C 8 and 9.

Fig. 2 will help to make this clearer. The upper figure A shows a section along the river valley in its straightest northerly course. The second figure B shows the average level for each square in column C, a process which smooths out accidents of topography and gives the average slope of the land for some

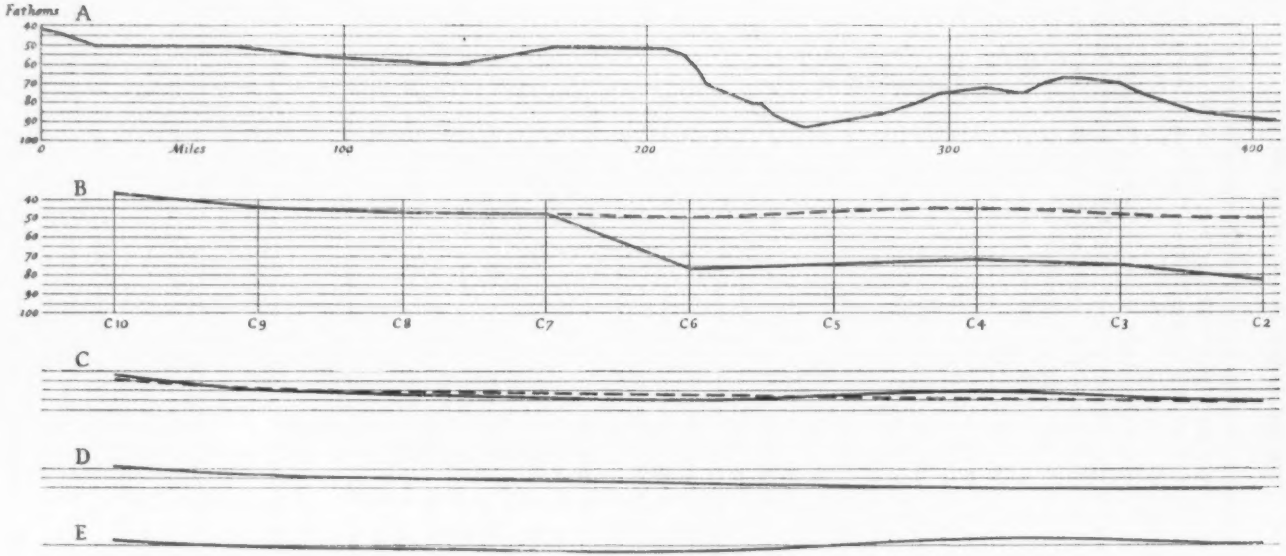


Fig. 2. A, *actual;* B, *average levels along Course 2* (*Fig. 1*)

distance on each side of the river bed, the width of a square of 2 inches on the chart being about 24 miles.

It is a reasonable assumption to make that the drainage here was mature, that is to say that water falling anywhere would find its way in streams to the river and on to the ocean, so that the average fall of the land (Fig. 2, B) should be the curve of a mature river (D). Contrary to expectation however there is, on the southern side of the scarp, indication of a steeper fall and, north of the scarp, a shallow anticline in place of a continued fall. This seems to be an undulation which ignores the scarp, and to show it more clearly the first part of the curve is continued as a broken line. Fig. 2, C, shows the last curve again (this time as a full line) on which has been imposed the curve of a mature river, D. By subtracting ordinates the curve of the undulation itself is arrived at (E). There is a maximum at C 4 and at the left-hand (Dogger Bank) end of the figure the curve is rising to another maximum.

Returning to the map, the maximum at C 4 is clearly visible in the way the contour lines cross over from the east westwards, while the southern maximum is not far to seek, for south of the Dogger Bank at line 12 there is a rise crossing from Holland to the Wash. This is the Haisboro'–Terschelling Rise, as Gregory named it, though from his sketch-map (3) one might imagine its trend to be north–south and not east–west, as is the case.

The distance between the two maxima of this undulation is roughly 400 miles, and they are each connected with phenomena which suggest that they may not be stationary but in motion.

To take the southernmost first: on the Dutch side to the south in the recent period Holland has been subjected to subsidence which necessitated the well-known engineering works which keep a large part of the country from being flooded. The Rhine, which, as stated above, probably flowed out through the Zuider Zee, has been diverted westwards; but the Dutch and North German islands have not suffered to the same extent, though the adjoining German coast has an embankment against high tides and is subsiding at a rate which has been estimated as high as 75 centimetres per century (5). The islands would therefore seem to lie on the crest of the rise.

On the English side, south of the rise there has been severe erosion in the recent period from, say, Clacton up to Southwold. Near Cromer the soft cliffs are suffering, but this is the end of severe erosion: along the north Norfolk coast there has been a period of deposition which seems to be coming to an end (6). In south Lincolnshire there are dunes suggesting a period of deposition, and rapid warping in the Humber indicating that some movement is in progress.

With this southern rise is associated an earthquake which occurred on 7 June 1931, and with the northern rise the earthquake of 24 January 1927, the epicentre of which is given at about 59° N. 2° 5′ E., which is in square D 5 of the map.

So far as the southern rise is concerned, the North Sea coastal phenomena are insufficient to determine whether the motion, if any, is to the north or to the south; though the severe erosion and subsidence to the south would support the idea of northward motion. The trend of this rise, which here is from a little north of east to a little south of west, if produced in a straight line,

would reach St. George's Channel at about Pembrokeshire, and there is certainly a recent beach in Wales which needs explaining; but other phenomena—the sluggish flow and winter flooding of the Avon; the extensive very flat (and so apparently recent) plains of alluvium at a small height above sea-level between Weston-super-Mare and Minehead—suggest that the trend is more south-westerly in crossing England, for instance, that the line curves from the centre of the Wash to Lundy Island. It is interesting in this connection that a slight earthquake was felt in 1934 at Bristol.

Turning to the northern rise: there are no thickly populated shores here to render small changes of shore-line noticeable. There is however the curving of the Neolithic Beach in Scotland into a flat arch, described by W. B. Wright (7), which accords with a south-westerly trend for this rise.

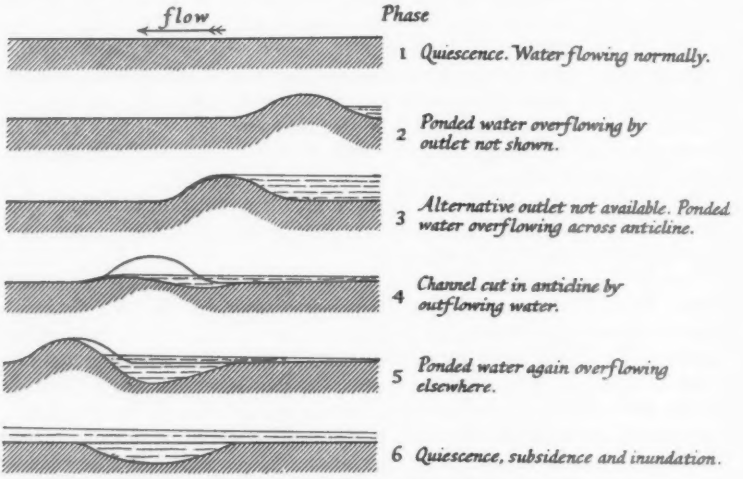

flow
Phase
1 Quiescence. Water flowing normally.
2 Ponded water overflowing by outlet not shown.
3 Alternative outlet not available. Ponded water overflowing across anticline.
4 Channel cut in anticline by outflowing water.
5 Ponded water again overflowing elsewhere.
6 Quiescence, subsidence and inundation.

Fig. 3. Possible method of formation of deeps

"The level," he says, "is at 5 feet in Caithness and Donegal while the beach reaches its greatest elevation of 30–35 feet at Loch Linnhe." The distance from Loch Linnhe to Lundy Island is again of the order of 400 miles.

Produced in the other direction into the Gulf of Bothnia, we might expect the rising movement there to be explained by this northern anticline. "Witting calculated a reduction of depth of about 0·2 cm. per annum near Gottland, about 0·5 cm. near Stockholm, 1 cm. or more in the Bothnia Wick. This last has put out of use the former harbours of Vaasa, Kokkola (Gamla Karleby), and Raahe (Brahestad)" (8). The movement is therefore more extensive and more rapid than could be accounted for by the anticline, and another movement is in progress which obscures the issue, namely the recovery of this area from isostatic depression due to the weight of the Pleistocene ice-fields. For this reason no useful deduction can be drawn from the Gulf of Bothnia rising in connection with the northern North Sea anticline.

Returning to our map, the Norwegian Deep goes down to 350 fathoms

north of Jutland, but on the west side of Norway seldom reaches 190. Taken in connection with the apparent successive extension westwards of the anticlinal fold, this strongly suggests an unequal original sinking of the two sides of the Scandinavian block and raises the question: Is the Gulf of Bothnia rising wholly due to recovery from isostatic depression? A discussion of this point is however outside the purview of this paper.

If the two anticlines noticed are travelling, and in the case of the southernmost there seems to be little doubt of it, the possibility that still larger anticlines may have travelled the same or another course in the past may throw light on two puzzling features, one being the deeps and the other a repeated east–west *motif* in the North Sea coast of Great Britain which begins in Sutherland and Caithness, is repeated on the south of the Moray Firth, again (not so clearly) on the south of the Firth of Forth, again (most clearly) in the 50-foot contour of north Norfolk, and again in the north coast of Kent. Some geologists hold that the south Moray Firth coast was fault-determined, a conclusion supported by the presence on the same line out to sea of the scarp referred to above; others that this coast was marked out by a monoclinal fold of geologically recent date.

In the case of the deeps, their extraordinary depth has always rendered it very difficult to accept the view that they are stretches of river valleys *in situ*, as it were. Furthermore, those at B 4, A/B 7, C 8, and D 12 seem not to be obviously connected with any river. There are also deeps in the English Channel bed not obviously connected with the river that flowed there. A very interesting solution of a puzzling problem is suggested by the possibility of anticlines that have since disappeared. To take the Wash River, C 12: when the ground here was above sea-level, an anticline of any height on the line 11/12 would tend to pond back the water to the south of it and, while it persisted, cause the Wash River to cut its channel deeper. Similarly, while the Strait of Dover remained closed, such an anticline disposed from side to side of what is now the North Sea would cause ponding to a depth depending upon the height of the anticline. The ponded water, if no convenient outflow channel (such as a river-bed capable of being rapidly deepened) presented itself, would of necessity overflow across the anticline and cut itself a channel of sufficient size, abandoning this later if the shifting of the barrier made a more convenient outlet available. The process is illustrated in Fig. 3, and the degree of flexibility demanded of the upper crustal layers is no greater than that evidenced in noted examples of folding.

Why these deeps, however formed, have not been filled up by the sand or gravel that covers most of the area must form the subject of individual conjecture.

This paper has endeavoured to describe the North Sea bed and point out some of its problems in consequence of Gregory's hint that our knowledge of the sea-floor is inadequate and that it is by no means a featureless plain of ooze.

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ON THE FLOW AND WATER-LEVEL OF RIVERS: A summary of the work of the author bearing the same title and published in the 'Researches on the rivers of the USSR,' Issue iv, 1932, pp. 1–82, of the State Hydrological Institute, Leningrad

PROFESSOR E. V. OPPOKOV, Member of the Ukrainian Academy of Sciences, Kiev

THE first chapter of this work contains considerations on the general course of the variations in the highest and lowest levels of the river Dnieper (in five years averages, compared consecutively every successive year, *i.e.* for the years 1852–1856, 1853–1857, etc.) observed at the village Lotzmanskaya Kamenka (below Dnepro-Petrovsk, at the beginning of the rapids, where the river-bed did not change) during the years 1852–1931 and in Kiev from 1873 till 1931. In the latter region the river-bed consists of sandy alluvium and varied considerably—by 1·2 m.—in height in 1872 and less markedly at the beginning of the 'nineties. The data which embrace the period 1860–1872, although existing, are therefore not given by the author as not comparable with the subsequent.

The data for the river Dnieper are shown on Fig. 1, and do not attest any unilateral progressive changes either in the lowest or highest levels of the river at the village Lotzmanskaya Kamenka.

As to Kiev, we see a certain lowering of the minimum river-levels, which was first observed at the beginning of the year 1890, after which period the levels become on the whole stabilized. At both sites the maxima of the highest levels are grouped about the years distinctive of the greatest floods of the Dnieper—1877, 1917, and 1931; the minima of the same levels are grouped about 1856–60, 1862–66, 1890–94, and 1910–14. The lowest levels exhibit minimum values in the following five years periods: 1871–75, 1888–92, 1897–1901, and 1920–24; their maximum values were observed about 1852–56, 1876–80, and 1893–97.

Fig. 2 contains data on the fluctuations of the highest and lowest levels of the river Seine in Paris from 1782 to 1931 and on mean annual levels (after Arago) for the period 1732–1858. The maximum values of the highest levels of the Seine in the periods 1740–44, 1747–51, 1768–72, 1798–1802, 1816–20, 1844–48, 1879–83, 1910–14 are sharply outlined on this diagram.

Most marked maximum values for the mean annual levels of the Seine were observed from 1768–72 till 1770–74, in 1805–09 from 1814–18 till 1816–20, from 1835–39 till 1837–41, and in 1852–56. As pointed out by the author in another paper the maximum values of the Seine for the years 1844–48 and 1879–83 coincided with the maximum levels of the Rhine in Cologne in the same quinquennia. The lowest levels of the Seine at Paris exhibit minima at the very beginning of the observations—in the years 1731–35, in 1741–45, 1758–62, and especially in 1764–68, from 1775–79 till 1777–81, about 1799–1803, 1822–26, 1839–43, 1846–50, from 1861–65 till 1864–68, and from 1891–95

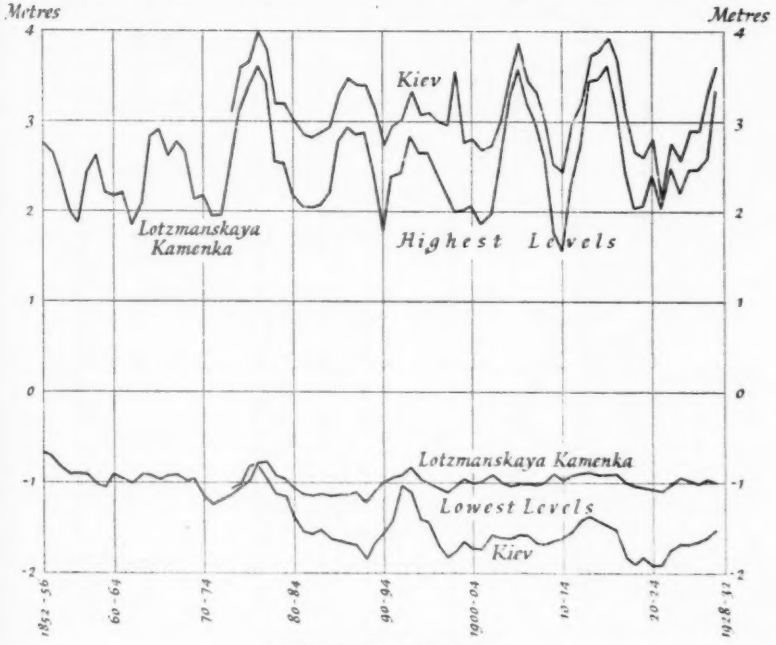


Fig. 1. River Dnieper

till 1895–99. A most marked fall, observed in the sixties of the last century, was compensated at a later period by the construction of mobile dams. Nevertheless this fall could be clearly observed at the end of the droughty period 1890–1900 in other regions of Europe likewise, as far as the basin of the middle and upper Dnieper inclusive.

We then see a most characteristic diagram (Fig. 3) of the river Rhine in Basel from 1806 to 1925 constructed from the data of Ghezzi. It is characteristic not only of the levels of the river but of the run-off of the river likewise. The author reminds us of the numerous suppositions and erroneous affirmations (beginning with the year 1837 indicated by Berghaus, the year 1842 indicated by Merian, and ending with the years 1873 and 1879 indicated by Gustav Wex) as to the would-be gradual decrease of the water in streams which

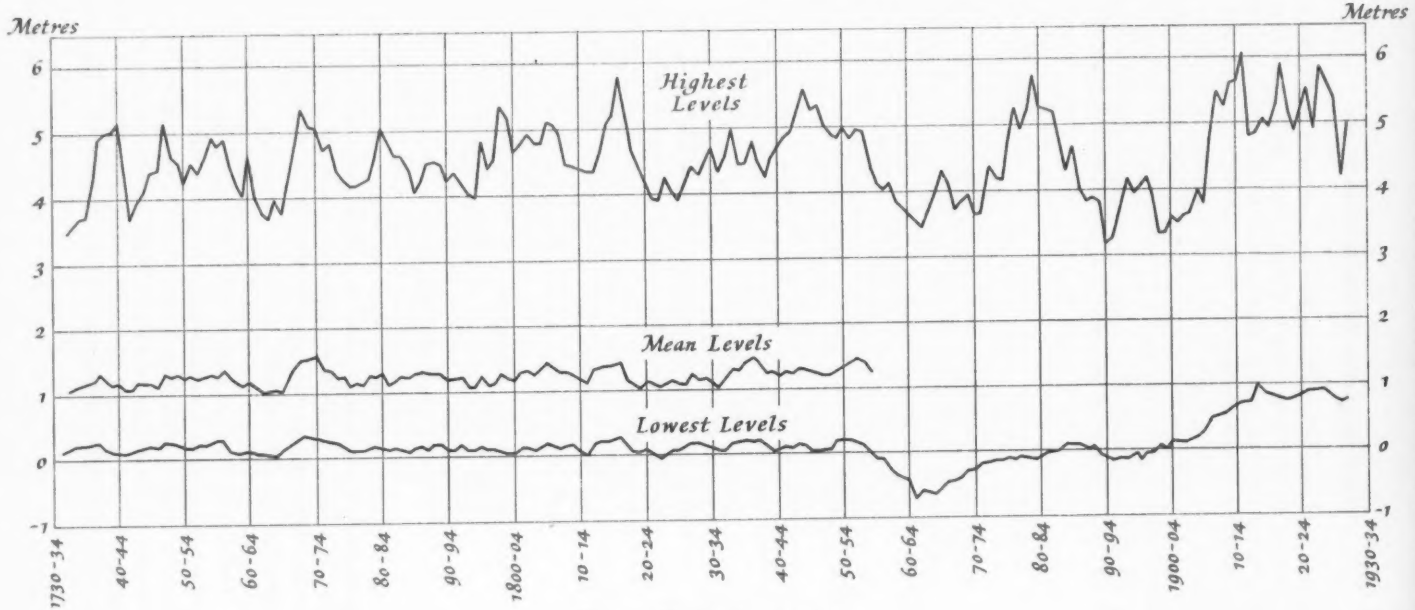


Fig. 2. River Seine at Paris

occurred periodically, usually after very droughty years. While the levels of the Rhine in Basel exhibit an indubitable fall in the course of time, caused by the erosion of the bottom and the deepening of the channel, the river discharge does not show any decrease in the course of time, as is clearly seen on the lower part of Fig. 3.

The author likewise cites observations on the Elbe at Magdeburg that embrace an even longer period than those on the Seine, namely from 1727 till 1870, published by Maas and also exhibiting a fall of the river-level as a

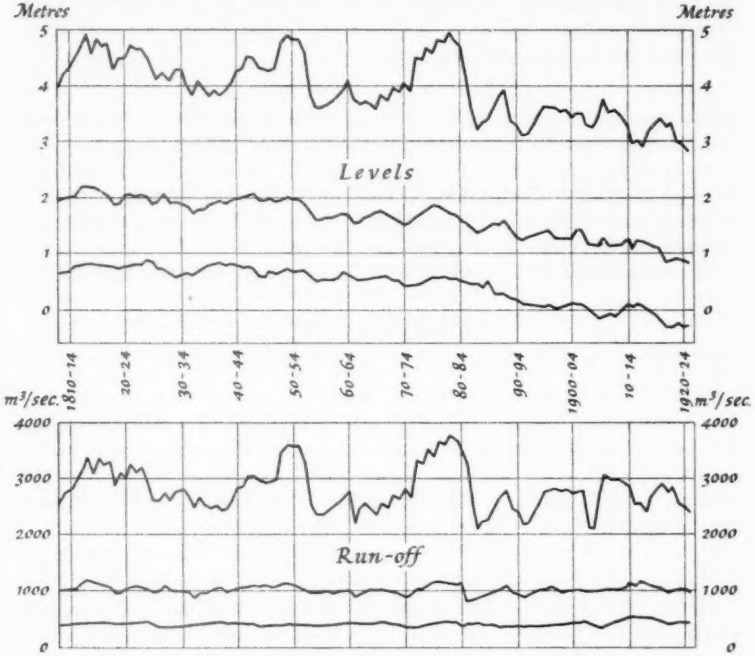


Fig. 3. River Rhine at Basel

result of the erosion of the bottom, caused by the construction of a road dam across the valley, as was also the case with the Dnieper at Kiev.

The sharply outlined fluctuations of the level of the rivers on the diagrams are to be attributed to the fluctuations of the atmospheric precipitations in the river basins in different years, as was shown in 1887 and 1890 by Professor E. Brückner. This is confirmed by the direct comparison of the course of the fluctuations of the river discharges with that of the atmospheric precipitations in their basins, cited by the author in respect to the Elbe in Bohemia for the years 1874–95, the Saale in Saxony for the years 1872–1901, the Dnieper in Kiev for the years 1876–1901, the Seine in Paris for the years 1861–1909, and some North American rivers.[1]

[1] *Mém. de L'Acad. des Sciences de St. Pétersbourg*, vol. xxii, no. 6, 1908.

In the second chapter the author examines the equations for the general water circulation in a river basin, given by Professor A. Penck in 1896, applicable only to the mean of a period of many years or in general to a closed cycle of a complete water circulation; he further examines the equation he proposed in 1904 for the water circulation in each separate year (*Zeitschrift f. die Gewässerkunde*, Bd. 6, S. 157) which differs from the Penck equation in that it introduces a complementary member, that provides for the "accumulation" and "consumption" of moisture, or the increase and decrease of the moisture supplies in the soil and subsoil of the river basin in different years. This equation bears the name of the Penck-Oppokov equation in Russian literature and has the following form:

$$x-z=y\pm t, \quad y=x-z\mp t$$

where x means the atmospheric precipitation in the basin, y the run-off, z the evaporation in the basin, and the member $\pm t$ corresponds to the moisture consumption from the soil of the basin, which takes place in order to cover the deficit of atmospheric precipitations below the evaporation in droughty and shallow water years, or for the recovery (accumulation) of moisture in the years following the droughty years.

The run-off equation for the basin of the Dnieper as far as Kiev has the following aspect:

$$y=0{\cdot}83(x-395) \text{ mm.}$$

It corresponds to the run-off equation for middle Europe of Professor Penck:

$$y=0{\cdot}73(x-420) \text{ mm.}$$

The author gives besides two equations—(1) for the spring run-off of the Dnieper at Kiev for the months March–June, depending on the atmospheric precipitation x from November till May and on the deviation Dt from the normal ($-5{\cdot}7°$ C.) of the winter temperature in the basin during December–February:

$$y=0{\cdot}405\,x-10{\cdot}45\,Dt-5{\cdot}08 \text{ mm.}$$

(2) The equation for the prediction of the height y of the rise of the highest water-level in spring at Kiev above the low river-level for the preceding winter, depending on the precipitation x from November till April and on the deviation Dt from the winter temperature normal in the basin during the period December–February ($-5{\cdot}7°$ C.):

$$y=0{\cdot}349x-13{\cdot}12\,Dt+121{\cdot}27$$

(y is given here in hundredth parts of a Russian sajen of 7 feet.) A more detailed examination of the problem of the correlations between the atmospheric precipitation, the run-off, and the evaporation for the basins of the rivers Dnieper, Elbe in Czecho-Slovakia, Havel, Weser, Tissa, and Dalelf is given in a separate paper by the author: "Run-off and Evaporation, as a Function of the Atmospheric Precipitations in a River Basin."[1]

The third chapter contains numerous data on the negative deviations of the water store of the rivers (low level) and on the corresponding climatic phenomena: fall of the ground water level, drying of marshes, burning of

[1] 'Works of the Research Institute on Water Economy,' vol. ii. pt. 2, 1929, pp. 143–170 (with a detailed summary in German).

peat-bogs and forests, formation of fords across large navigable rivers, such low levels of the water in the Rhine that stones lying on the bottom of the river and bearing on them carved inscriptions of the years of anterior droughts appeared above the water, etc.

We find evidences of the existence of such fords on the Rhine dating from the year 70 of our era, on the Dnieper in its middle and even lower course dating from the twelfth century, on the Volga from the seventeenth century. The author cites the description of the floating of ancient boats (*ὀνόξυλα*) (canoes made of a single bole) through the rapids on the Dnieper in the tenth century given by the Greek writer Constantine Porphyrogenetus. The author also refers here to the data of the west European chronicles beginning from the sixth century, and Russian chronicles beginning from the tenth to eleventh centuries, mentioned in the works of Schnurrer (1823), Müller (1823), Reis (1883), Hennig (1904), of the author himself (1904), Bogolepov (1907–1911), and others.

Towards the end of the chapter we find data concerning the shoal-water of the rivers and the phenomena that accompanied it beginning with the year A.D. 912 till the year 1928 inclusive. For the two last centuries we find data on the lowest river levels according to hydrometric observations (on the Elbe since 1727, and on the Seine since 1731).

The fourth chapter contains data on the positive deviations of the run-off of the rivers, beginning with the evidences of Chinese chronicles on the inundation in China 2297 years before our era and with the legends on the universal deluge of Babylon contained in the Bible and ending with the data on the flood of the Dnieper in 1931.

The author also makes use of a diagram of the Nile floods in the years 641–1451, given by Brooks in 1928, and a diagram of Lyons for the Nile floods at Roda from 1737 till 1800, from 1825 till 1872, and of the discharges of the Nile at Assuan since 1869 till 1903. He also quotes Borhardt's indications on the marks of the high levels of the Nile since the year A.D. 900 from his article on Nile gauges (1906). Reference is made to Reis's evidence on the floods of the Rhine in Mainz since the year 1342, to Perronet's indications on the overflows of the Tiber in Rome since 1280, to Pascher's indications on the overflows of the Danube in Vienna since 1402, and to the work of Champion (1856–64) on the inundations in France in the sixth century, etc. The last part of the chapter contains a list of historic evidences concerning large inundations and severe winters and, for the last two centuries, concerning high river-levels according to the data of direct observations.

In the fifth chapter the author discusses the problem of the periodicity of the repetition of such phenomena as shallow water in the rivers and large inundations beginning with the four year periods of Plinius and Eudoxius and ending with the eleven year periods of the solar spots of Fritz (1878), the 110 year periods of the same spots of Reis (1883), and the 76·7 year periods of Brooks. The author admits the probability of a 450–520 year periodicity mentioned by Brooks in his work of 1928. The author believes however that owing to the lack of data for whole centuries, even for instance for the sixteenth to eighteenth centuries, it is impossible to establish a regular periodicity; he does not deny a certain probability of Brückner's thirty-five

year periodicity, but points out that more frequent fluctuations occur in the limits of these periods and more lengthy ones beyond the latter.

The presence of evidence dating from the tenth century however concerning the floating of small boats through the rapids of the Dnieper under approximately similar conditions to those under which the floating of boats across the rapids took place with the help of the pilots till the construction of Dneprostroy and the evidences of the existence of fords on the Dnieper in the eleventh century at the same places in the middle and even lower course of the river, where they appeared but comparatively rarely in certain years of the last centuries, lead us to infer without doubt that no marked variations whatever have occurred in the run-off of the rivers in historical times, the more so as no changes have taken place in the climate during the post-glacial period. And inasmuch as "the rivers are a product of the climate of the country" according to the characteristic expression of Professor A. J. Voekov (1884), they may attest but the fluctuations of the climate and not its changes. There are no grounds whatever to presume that any such changes have occurred in historical times either in respect to the run-off of the streams or the climate. Direct historical evidence on the character of the run-off of the streams does not provide any data attesting a different character of the latter in the past if compared to the one we witness at present. Considering this we must regard the statements of Berghaus, Wex, Götz, König, and others as to the progressive decrease of the water on the Continent in the course of time, the fall of the level of the ground waters, etc., as undoubtedly erroneous.

In Chapter VI, written as a supplement after the work had been completed, the author cites Dr. Soldan's similar inferences on the same problem drawn from his report to the German Engineers' Society [1] in 1924, with which the author became acquainted after having finished the article.

Besides the work of Wussow on the droughts in Germany, mentioned in the conclusive fifth chapter, the author brings in supplement to the works of Professor Koehne (cited by him) on droughts and the lowering of the ground waters in Germany in the years 1904, 1911, and 1920–1921 (which were likewise observed in the same years in the basin of the Dnieper) an interesting diagram of Professor Brückner (1888), little known in literature and which shows characteristic fluctuations and falls of the ground waters level at the end of the years 50–60 and 70 (1873–75) in Munich, Bremen, and Berlin. We see the influence of the fluctuations in the years 1873–75 in the exceedingly shallow water of the Pripiat in the Dnieper basin. A marked fall of the ground water level in the flat plain basins of the rivers in Germany and in the adjoining Dnieper basin is the best proof of the presence and large dimensions of the "consumption" of moisture from the grounds of plain river basins in droughty years, which compensates the lack of atmospheric precipitations in such years in order to cover the needs of the moisture evaporation from the river basin into the atmosphere.

Index of works (112 in all) referred to on the subject of the run-off and fluctuations of rivers and ground waters is provided in the article.

[1] *Der Bauingenieur*, 1924, H. 15.

THE PAPER INDUSTRY OF THE PENNINES

R. WALLACE

The Physical Background

THE Pennine Highland is the dominant feature in the relief of North England, and has a length of about 150 miles and a mean width of 50 miles. That part of it south of Craven Gap may be divided into two sections; from High Peak northwards the surface rocks are composed chiefly of the Millstone Grit series, while to the south of Rushup Edge the landscape is formed principally of the Carboniferous limestones. This essay is concerned primarily with the grit area and the valleys on the east and west which have been cut into it.

All hills south of the Ribble with the exception of minor uplands in the Lancashire Plain have been developed from the Millstone Grit and Coal Measure series. It seems evident that the latter once had a continuous extension between the coalfields of South Lancashire and those of the West Riding of Yorkshire. Erosion however has completely removed the coal from the summits of the Pennine Arch where the older grits are now exposed. The Rossendale anticline has its main axis aligned north-east–south-west, and the Coal Measures here are only partially denuded. Over the lower south-west extremity certain of the richer Coal Measure series are continuous, and here are found such coal mining centres as Wigan and Atherton. East of St. Helens, the middle Coal Measures are overlapped by Triassic deposits, and in conformity with the embayed configuration of the uplands to the north and east of Manchester, the coalfield extends south-east into Cheshire.

The scenery and the vegetation of the Grit Moors offer sharp contrasts with the dry grassy hills of the limestone regions. The flat summits of the former are covered with peat bogs and the slopes with heather, the soil is generally sour and supports a poor vegetation. The abundance of soft water which the streams can send down to the neighbouring valleys is of great importance to industry, and the whole of this area is now reserved as a gathering ground, supplying towns in Lancashire and Yorkshire.

Before describing the location of the paper industry in detail, some account must be given of the economic background, as otherwise it is difficult to understand the relation of the paper industry to other industrial activities in the area.

The Economic Background

Most of the industries located in the region have developed from many causes, generally from a combination of geographical, economic, and historical factors. It is extremely doubtful whether the paper industry of the Pennine region would have attained its present status but for the tremendous growth of the cotton and woollen industries—to name the two most important ones in east and south-east Lancashire and the West Riding of Yorkshire—during the century preceding the Great War.

Unfortunately the size and relative importance of these industries, together with those of chemicals and coal mining, have tended to attract attention, and to throw others into unmerited insignificance. The web of specialized

services in transport, distribution, commerce, and finance, which has in large measure been provided to meet the needs of the staple trades, has created an environment which other industries have found favourable for production. These services, together with the market provided by the ten million consumers in the area, have induced the growth of other industries.

As the paper industry owed much of its development to the presence of the above factors, most of the mills in the area are of comparatively modern growth. Lancashire's first mill was established at Garstang in 1820, but the growth of the industry was most rapid during the last thirty years of the nineteenth century. At the present time the whole area contains nearly eighty paper mills, with an annual production of 450,000 tons. Under the circumstances the quality of paper produced is determined largely by the needs of the cotton and woollen trades, such things as stationery, newsprint, and wrappers of every description are in great demand. Originally rags, textile waste, waste papers, and straw were used principally as the raw materials, but it soon became manifest that this supply was hopelessly inadequate. Wood pulp and esparto grass had therefore to be imported from abroad to supply the needs of a rapidly expanding industry.

As the industry thus became increasingly dependent on overseas raw materials, it might have been expected to migrate towards the ports to some extent; this however has not taken place. The absence of paper mills in south-west Lancashire and Liverpool in particular—apart from one mill established on the Wirral, which manufactures newsprint—is rather surprising in view of the concentration of industries since 1900 along the Manchester Ship Canal from Runcorn to Trafford Park (see map).

That this fact is not always realized is proved by the following quotation, taken from Dr. Stamp's recently published book on Great Britain (see p. 540). Referring to the paper industry, he says: "Hence the dominating factors determining the situation of the factory are proximity to tide-water and accessibility of large consuming centres." He then goes on to quote Merseyside as supplying Lancashire and the North of England. Apart from the fact that Preston is the principal port supplying the area, the absence of paper mills in south-west Lancashire mentioned above, proves that the proximity of markets or nearness to tide-water is not the sole factor in determining the location of a mill site. Natural factors have played a considerable part in the location and, among these, water supply is particularly important.

Water Supply

The quality and quantity of the available water supply is an important factor in determining the location of a mill site. Water probably plays a greater part in the manufacture of paper, and paper board, than in any other industry in the region. It is employed in every branch of manufacture from washing and bleaching the raw material, to the final process when the paper appears on the finishing frame. The amount of water used varies with the kind of raw material employed in the manufacture. The following table gives the amount for each class of paper:

Paper made from rags	.. ..	80,000–100,000 gallons per ton
" " " esparto grass	..	25,000– 50,000 " "
Newsprint	..	7,000– 12,000 " "

The amount of water used with wood pulp varies according to the quality of the paper to be manufactured.

Paper mills draw their water supplies from surface streams and reservoirs, and from wells and bores sunk in the ground. In the Pennine area the former source is usually the most important. Streams and reservoirs are dependent on the rainfall of the area for their water, and it seems that the distribution of rainfall is an important natural cause of the location of mills on the flanks of the Pennines.

Rainfall and Run-off

Reference to the map will show that the towns containing paper mills are found in areas which have an annual rainfall of 25 inches or more. The prevailing winds blow from the west and south-west and are generally warm and moisture laden. On rising above the higher ground they are compelled to drop some of their moisture, and as a result the western valleys have a higher rainfall than do those on the Yorkshire side. On the moors the annual rainfall is well over 60 inches, and much of this water finds its way into streams and reservoirs. The fact that the rainfall tends to be heaviest on the western flanks is proved by the following figures taken from the *Geological Survey Memoir* of the Holmfirth and Glossop area. At Woodhead the average rainfall is 50·18 inches per annum, at Ingbirchworth, less than 8 miles to the east, the amount falls to 38·89 inches.

From the point of view of paper making the amount of water available for industry depends not so much on the amount of precipitation but on the run-off, which varies in different localities over the area. Owing to the artificial conditions prevailing over many of the moorland areas, *i.e.* the presence of catchwaters, reservoirs, pipe lines, etc., it is difficult to obtain figures in such a form as to indicate the actual run-off in relation to rainfall. On the whole there is less loss of water due to evaporation and percolation, in the Grit areas, than there is in the surrounding lowlands.

Finally the topography of the former favours reservoir construction. The comparatively narrow valleys carved out of the Shales, Coal Measure series, and Millstone Grits, have afforded many reservoir sites. Also the peat deposits, which occur over large stretches of moor, act like sponges, checking flooding during a period of heavy rainfall and tending to maintain a steady flow during a prolonged spell of dry weather.

Quality of Water

Another important factor, from the paper manufacturers' point of view, is the general soft quality of the water, which rarely exceeds 10° Clark in hardness, and on the average is 5° (1° Clark—1 part of calcium carbonate in 70,000 parts of water). The water, when filtered, is exceptionally good for paper making, especially for high quality and all white papers. For such papers it is absolutely essential to have carefully filtered water, otherwise both quality and colour would always be at the mercy of the weather. Heavy rainfall brings down large amounts of vegetable and solid matter which would, if not removed by filtration, cause spots to appear on the finished product. The presence of iron is especially troublesome in paper making, as owing to com-

bination with cellulose it "yellows" white papers, and "dulls" coloured ones. In the making of high-grade papers the maximum amount of iron permissible is generally 0·1 parts per 1,000,000 parts of water.

Hard waters are not used except in very special circumstances. Such waters tend to deposit a scale on the interior of pipes and boilers thus causing a large loss of fuel during heating processes. They are unsuitable for washing wood pulp as they cause insoluble calcium resinates to be deposited thereon, thereby rendering the product unnecessarily hard to bleach. More disadvantageous still, hard waters are unsuitable for sizing purposes. Sizing effects a strengthening and water-proofing of the paper and is carried out by treatment with resin and alum. The consequences of impurities occurring in the natural waters are shown largely in the sizing process. Salts of lime and magnesia, while without any serious influence on the pulp itself, interfere with the precipitation of resinate of alumina in the sizing process. Such salts, if present in large quantities, react with the size, forming insoluble resinates which have no sizing action, and waste all the alum. Moreover the salts in the water affect the colloidal condition of the size, making the resin form into large particles and thereby reducing its covering power.

Underground Water Supplies

Despite the plentiful supply of pure and soft water available for domestic and industrial purposes, continuous expansion has forced several townships and industrial concerns to resort to boring in order to supplement surface supplies. In view of the fact that a suitable water supply is of prime importance to the paper industry, it is worth while considering the storage capacities of the different strata.

The majority of borings can be divided into two classes, those in the Carboniferous, and those in the Permo-Triassic rocks.

In the Huddersfield and Halifax district, the millstone grits and lower coal measure sandstones are of considerable importance as sources of underground water supplies, and in many cases have yielded a copious supply of excellent water. In the Rossendale area, a large proportion of bores sunk in the millstone grits have been eminently successful, but in both instances the porosity of the grits militates against their usefulness as a continuous source of water. Borings have also been sunk in the coal measure sandstones, but the water here is appreciably harder than that obtained from the millstone grits, and at Huddersfield it is of a character quite unsuitable for any purposes except cooling.

It thus appears that the underground sources of water are of little help to the paper industry except during a prolonged drought. For although considerable supplies of pure soft water, hardness 3° Clark, can be obtained from the grits, they cannot be relied upon to give a constant and regular supply of water for any length of time. The water obtainable from the Permo-Triassic rocks is generally much harder than that obtained from the grits. At Pontefract, where water is obtained from the New Red Sandstones, the hardness is 12° Clark.

On the Lancashire side of the Pennines, Liverpool draws its water from several areas. At Rimmington above Bolton in the grit region, the hardness is 4·62°, but the water obtained from wells on the Trias in Liverpool itself

has hardnesses of 9·9° and 24·2°. A further disadvantage from the industrial point of view is the fact that water from the same well becomes progressively harder with lapse of time. The Green Lane Well at Liverpool in 1850 had a hardness of 7·5° Clark, by 1918 the hardness was 24·2°.

Conditions during Drought

It might appear that undue importance is attached to the question of water supply as a natural factor in the location of the industry. I think however it is correct to say that the presence of an abundant and suitable water supply is as important to the paper industry as an efficient transport system or its proximity to markets. This was very apparent during the extremely dry summer and autumn of 1933. The following were the conditions at two mills in Lancashire, both of which are modern, and endowed with the most up-to-date plant. Information was supplied by the chemists in both instances.

At a mill near Blackburn, the levels of the Reservoirs at the side of the works were low owing to the dry spell. The water was filtered before being used, and had a hardness of 7·9° Clark. Some time previously water had been discovered in an old coal working under the mill site. Although a copious supply of water could be obtained from this source, little use could be made of it, because it was very hard (35° Clark). It was used only in exceptional cases, and in very small amounts to supplement the ordinary supplies.

The position at a mill in Radcliffe during September 1933 was very similar. According to the chief chemist, that summer was the driest for fifty years and water from the river had to be used to augment the reservoir supply. Of the total amount of water employed in the mill 50 to 60 per cent. was river water. Before being used it had to be filtered, and treated with sulphate of alumina and chlorine and ammonia gas to kill organic matter. Filtration and chlorination reduced the iron and organic impurities to practically nil.

The above facts illustrate the dependence of paper mills on a plentiful and suitable water supply. In an ordinary season the reservoirs alone would have been able to supply most demands made upon them. Moreover the unsuitability of underground water supplies, especially from the coal measure series, and the dangers of pollution from rivers are also demonstrated. The pollution of the East Lancashire streams and rivers by refuse from the various mills and factories along their banks has forced certain industrial concerns farther up the valleys, where water supplies are more plentiful and the streams considerably purer.

The Development of Preston

One of the most striking features in the Lancashire paper industry is the large part played by Preston in the import of overseas raw materials. It would seem that Preston owed its origin as a port largely to the growth of the paper industry in East Lancashire and West Yorkshire.

In 1881 Liverpool was the only important Lancashire port, and in that year imported 50,818 tons of raw materials for purposes of paper making, the most important item being that of rags. At that time there was no dock at Preston, and the small vessels which visited the port had of necessity to be of very

shallow draft, and discharged their cargo with their own tackle at a short quay in the tidal river.

The depth of water in the river did not admit of navigation by vessels drawing more than 13 feet. Main imports consisted of small cargoes of corn, meal, oats, barley, wheat and round timber from coastwise ports.

With the growth of the paper-making trade in East Lancashire however the Port Authority at Preston was alive to the possibilities of future development. In 1883 it was decided to divert the course of the river Ribble, and construct a dock. The work was completed in 1892, the dock having an area of 40 acres. Since that time it has been deepened, and the channel confined within training walls, for a distance of $14\frac{1}{2}$ miles seaward. Equipment was erected for the rapid handling of wood pulp and esparto grass, with the result that Preston gained a reputation for safe and rapid despatch among the mills and shipowners alike. It is also the nearest port to the large paper mills in the Blackburn area, which take very large quantities of raw materials, principally wood pulp, from the Baltic. The following table showing the imports of raw materials for paper making during a period of years illustrates how Preston has secured a large percentage of the import trade in such materials. Figures are given in tons.

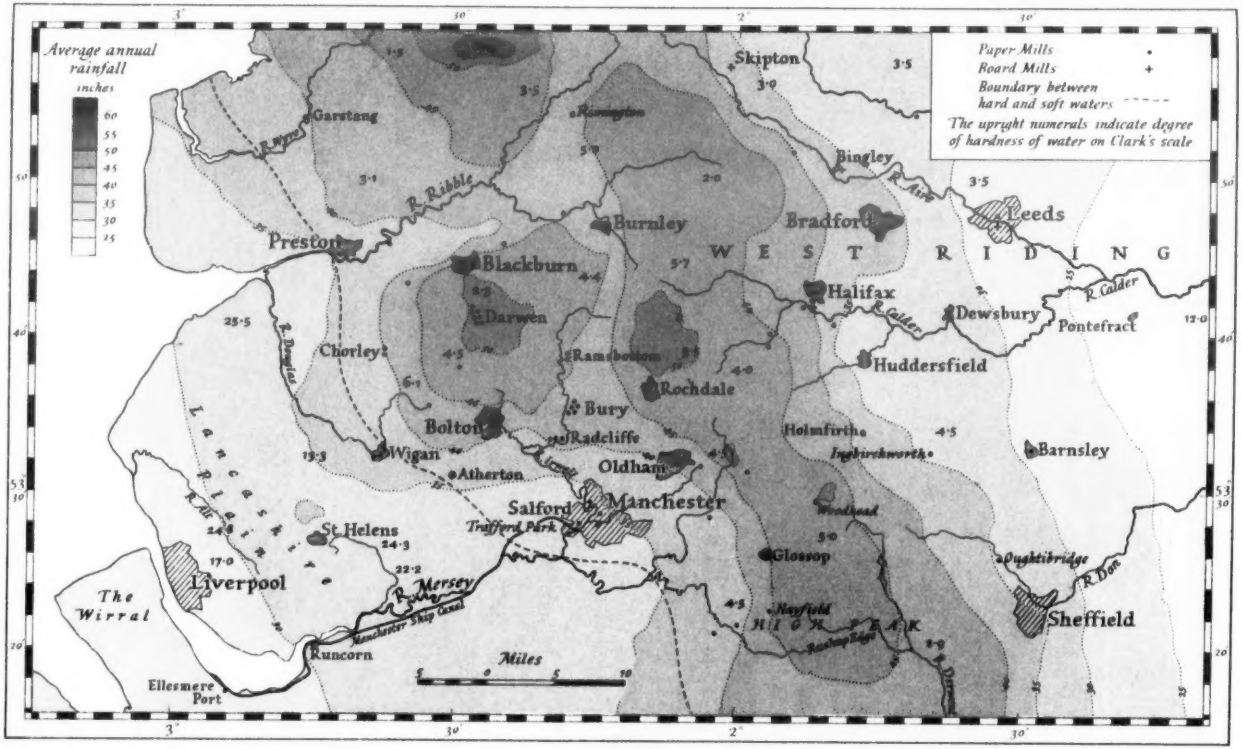
Year	*Liverpool*	*Manchester*	*Preston*
1895	38,484	64,907	Roughly 700 [1]
1913	22,863	129,004	153,115
1927	16,210	26,260	228,482
1933	14,660	155,498	195,373

Since the war however and until a few years ago imports into the region were lower than the pre-war figures by 40,000 tons. During the decade 1921–1930 imports through Manchester decreased considerably on the 1913 figure, in spite of the numerous mills located in the Upper Mersey Basin. I found on inquiry that mills at such places as Radcliffe and Hayfield—to name two only—obtain a large proportion of their imports through Preston, and not through Manchester, as might have been reasonably expected (see map). One reason for this is that direct shipments coming to Preston are often utilized for bringing part consignments of wood pulp designed for these other towns, to which the railway rate is a negligible factor as compared with the earlier delivery given by frequent and direct shipments through Preston. In other words, if there happen to be no immediate sailing to Liverpool or Manchester, and one or more to Preston, consignments might possibly be sent there for the benefit of immediate shipment and early delivery.

Since 1931 however imports into Manchester have risen considerably, due partly to the erection of a large mill on the Wirral, which manufactures newsprint.

It will be seen that imports into Liverpool are very small compared with the imports of wood pulp which go through Preston and Manchester. At the moment Preston is still the most important port in Lancashire and Yorkshire for the importation of paper-making materials. It will be interesting to see

[1] Official figure not available; this figure obtained from the Port of Preston Authority.


Average annual rainfall
inches
60
55
50
45
40
35
30
25
Paper Mills
Board Mills
Boundary between hard and soft waters
The upright numerals indicate degree of hardness of water on Clark's scale
Skipton
Garstang
Preston
Burnley
Bradford
Leeds
Bingley
Blackburn
Darwen
Halifax
Dewsbury
Pontefract
Chorley
Ramsbottom
Rochdale
Huddersfield
Bury
Bolton
Radcliffe
Wigan
Atherton
Oldham
Holmfirth
Barnsley
Salford
Manchester
Trafford Park
St Helens
Glossop
Liverpool
Mersey
The Wirral
Manchester Ship Canal
Runcorn
Ellesmere Port
Sheffield
Penistone
Miles
WEST RIDING
Lancashire
R. Ribble
R. Calder
R. Aire
R. Don
R. Douglas
R. Irwell
R. Mersey
5
0
5
10

in the next few years whether it will retain its position, in face of increasing competition from Manchester. The greatest drawback at the moment is the fact that Preston is not a great exporting centre for goods other than coal and coke, and in consequence vessels are often compelled to leave light. With increased sailings to Scandinavian and Baltic countries, and with the improvements in handling goods, this defect may be remedied in future years.

Conclusions

It would seem that the paper industry of the Pennine region depends upon the following natural factors:

(*a*) The presence of a plentiful supply of water which is exceptionally good quality for the purposes of paper making.

(*b*) As the water is principally surface water and because the supply is dependent chiefly upon rainfall and run-off, mills tend to be found on the flanks of the hills where water is more plentiful and streams considerably purer than in the surrounding regions. I do not think that the presence of a mill on the Wirral contradicts this statement. The chief article manufactured there is newsprint, which requires on the whole a smaller amount of water per ton than is required for other classes of paper. Also the sizing process is not so important in the manufacture of newsprint, and consequently there is less demand for a water of soft quality than there is elsewhere.

(*c*) It is also apparent that underground supplies of water are of little help to the paper industry, both in respect to quantity and quality; and hence it is unlikely that the industry will move towards the ports, despite the proximity to raw material supplies and the market which such areas necessarily provide.

(*d*) It follows that the ports nearest to the flanks of the hills tend to secure the import trade in raw materials; the development of Manchester and Preston clearly illustrates this fact.

Finally, to neglect the economic background is to give a false impression. Without the market provided by the industries already located in the region, the paper industry would never have attained its present importance. The economic and physical factors have thus both co-operated in creating an important minor industry, but experience shows that on certain occasions the question of water supply is even more important than the proximity of markets.

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— — "South East Lancashire" (1931), pp. 207–09.
— — "Holmfirth and Glossop" (1933), pp. 168–71.
— — "Huddersfield and Halifax" (1930), pp. 171–73.
— — "Liverpool District" (1922), pp. 128–31.
"Great Britain," Essays in Regional Geography. Chapter on Pennine Area.
Clapperton and Henderson, 'Modern Paper Making,' chapter 22.
Pollitt, 'Technology of Water Supply,' pp. 72–92.
Stevens, 'Paper Mill Chemist.' Chapters on Water Supply and Hardness of Water.

The map is based upon information derived from the Paper Manufacturers' Directory, and British Rainfall.

The information about Preston was derived chiefly from two letters supplied by the Port of Preston Authority and by the Preston Chamber of Commerce.

Much information concerning reservoirs sites, quality of moorland water, etc., was supplied direct by the water engineers employed by the different towns and cities in the area.

The Council have awarded to this Essay the prize offered for an Essay of not more than 5000 words; either a critical survey of recent additions to knowledge in a limited geographical field, or a discussion of some problem in its geographical aspect. The writer has made some slight revision of the Essay before publication, and separate maps which accompanied the Essay have been redrawn in one by the Society's draughtsmen.

The conditions of the competition for 1936 were announced in the 'Journal' for May 1935, vol. 85, p. 482.

THE CHISHIMBA FALLS IN NORTHERN RHODESIA

VERNON BRELSFORD

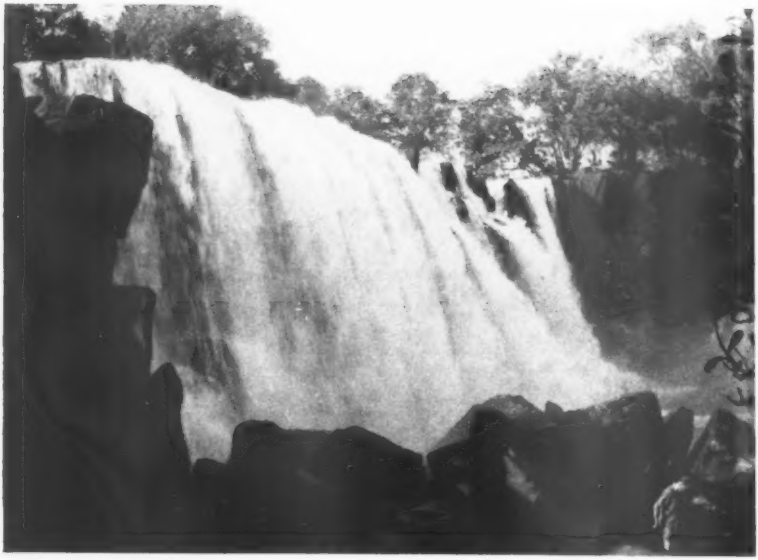
THE Luombe river in Northern Rhodesia runs a course of over 100 miles. Ninety miles from its source it falls over series of limestone ridges, dropping over 200 feet in $1\frac{1}{4}$ miles. The falls, by reason of their being well off the beaten track, are rarely visited, although after the Victoria and Kalambo falls they are the most imposing in Northern Rhodesia. The area surrounding them is still regarded as a sacred place by the Babemba natives, and the legend, related later, accounts for the names of each fall and for the fact that no native village is built within a radius of 6 miles.

The first of the drops, by name Chipondo, is a cataract divided into two portions by a small island, and the river bed falls only 10 feet. A winding stretch of calm water, 500 yards in length, leads to Kayela, the second fall where the river drops abruptly 30 feet. The quarter of a mile between this and the third fall is turbulent water full of jutting rocks and contains a small thickly wooded islet half an acre in size. Mutumuna, the third fall, has two distinct drops, the first of 9 and the second of 12 feet. 250 yards of rough water lead to the sudden drop of Chishimba, the main and last fall.

Here the river falls a sheer 80 feet over a ledge 50 feet wide, and then continues gradually through a rocky gorge for another quarter of a mile. It is a magnificent sight, the foot of the falls veiled by continual spray, and the dense surrounding foliage dripping with moisture. Gusts of wind blow up periodic fine rain, and at all times of the year a half rainbow is visible in the gorge. Both banks of the river are thickly wooded and wild date palms (*Phoenix Reclinata*) fringe the water. Dense thickets of *Syzygium* species overhang the edges of all

Chishimba, the main fall

Mutumuna, the third fall



Kayela, the second fall

Chipondo, the rapids

three falls, their branches intertwined with lanias and creepers of many kinds, which I have not identified. Farther away from the water are many trees of the *Brachystegia* species and *Isoberlinia* genus, the Pog Mahogany (*Afzelia Quanzensis*), and here and there a handsome specimen of *Amblygonocarpus Obtusangulus*. All these trees are typical of the woodlands of the plateau of North-Eastern Rhodesia. I found several clumps of young bamboos, but no mature trees: this was probably due to the ravages of wild pig, of which spoor was seen. A wild aloe plant is plentiful, and in the gorge of the main fall three ferns (probably Adder's fern, Adder's Tongue fern, and a Filmy fern).

The bird and animal life in the immediate vicinity of the falls is not as large and varied as one would expect to see close to a river of this size. During my last visit of a week's duration, I saw two Rock Buntings who were nesting there, and a White Breasted Diver visited the water between the main and third falls daily. The ubiquitous Black-headed Bulbul was seen often, and one day a few migratory English Swallows appeared, whilst every night at sunset three parakeets flew screeching home to roost. These, together with a few finches, were all the birds seen during several visits at various times of year. The only game I saw were five eland and four waterbuck, but spoor of pig was fairly common. The lack of game is accounted for by the fact that the native hunter from Kilubula Mission hunts regularly in the vicinity.

The falls are in what is now the country of the great Wemba tribe, and they have an interesting story attached to them. Many years ago when the Balungu people occupied this area, a petty chief, by name Chishimba, lived close by the falls. He had some lamps made of a hollow stone, holding vegetable oil and a wick, of which he was intensely proud and jealous. Many attempts had been made to steal them and they were carefully hidden. A neighbouring headman eventually conceived the idea of luring Chishimba from his village to a palaver, bribing one of Chishimba's sons to betray the hiding place, and stealing the lamps during the palaver. This was done. On his return Chishimba was heart-broken at the betrayal and theft, and he resolved to commit suicide by throwing himself over the main fall. His people, all loyal to their head, said they would follow him. On an appointed day then, the village was burnt and all the goods and chattels flung into the river. Then Chief Chishimba cast himself over the main fall which now bears his name. His son-in-law Mutumuna went to his death over the third fall, Kayela, his first wife, over the second fall, and Chipondo, another son-in-law, in the rapids. The rest of the village followed and the four falls now bear the names of Chishimba and his family.

Soon after this, Nakatonya, a priest, came to live close to the site of the old village. He was a rainmaker and every year in November oxen were killed, beer was drunk, and incantations said on the brink of the falls. This went on year after year until in 1899 the White Fathers established Kilubula Mission 5 miles away. Their influence was great enough to cause the pagan rites to cease, and now the vicinity of the falls is deserted and free of villages. It is interesting to note that the Babemba have now filtered into the area, but 6 miles from Chishimba, surrounded by villages of the now dominant tribe, lives Nakatonya, a descendant of the rainmaker and headman of a Lungu village. The Babemba have respected the sanctity of Chishimba and it is still a deserted area, the nearest village being that of Nakatonya.

'HINTS TO TRAVELLERS'

HINTS TO TRAVELLERS. Eleventh Edition. Volume I: Survey and Field Astronomy. By E. A. REEVES, Instructor in Survey, R.G.S., 1901–33. With some additions and revision by other hands. *In dark blue cloth, gilt,* $7\frac{1}{2} \times 5$ *inches;* viii+448 *pages; with many illustrations and figures in text,* 5 *plates, and* 2 *star charts.* 16*s, or to Fellows at the House of the Society* 12*s*

R.G.S. ANGLE BOOK of 90 leaves. $10\frac{1}{2} \times 5$ *inches; bound in white sheepskin, as described with an illustration in the above volume.* 7*s* 6*d; and*

R.G.S. COMPUTATION FORMS Nos. 1 to 6. Reproduced with worked examples in the above volume. *Made up in blocks of* 50 *sheets* 10×8 *inches.* 3*s per block. Sold at the House of the Society*

AFTER some long delay, unfortunate, but in the circumstances hard to avoid, the Eleventh Edition of the first volume of 'Hints to Travellers' was published on September 16, and the second volume should follow next year. The volumes have hitherto been sold together, but they have become so entirely different in scope and interest that when the last revision was undertaken the Council on the advice of the Research Committee resolved that they should in future be published and sold separately, but retaining the original, though long since insufficient, designation of 'Hints.'

In the Tenth Edition, of 1921, the first volume dealing entirely with Survey and Field Astronomy received certain essential revision and a few additions, but remained substantially as prepared by Mr. Reeves for the Ninth Edition of 1906. For an eleventh edition nothing less was required than a complete overhaul of the chapters on Survey, and almost entirely new chapters on Field Astronomy. The principal instruments had been greatly developed; the *Nautical Almanac* had been twice recast; Radio time-signals had simplified and vastly improved the determination of longitude; the aeroplane had been added to the equipment of well-found expeditions. These developments affected more profoundly the technique of the scientific explorer than the regular surveyor, for the former relies much more on astronomical methods than the latter, and oblique air photographs in reconnaissance over new country offer more exciting possibilities than the verticals in ordered strips of the regular air topographer.

By 1931 Mr. Reeves had completed the heavy task of reconstruction, and in 1932 the manuscript was put into proof, with the intention that its publication should nearly coincide with his retirement from the service of the Society in June 1933. But ill-health made this impossible, and he was compelled to leave the last stages of the work to others. He was succeeded in the Instructorship by Mr. W. M. Gilmore, who gave much time to the correction of the proofs, and made valuable suggestions for the improvement of certain sections, especially those on traversing, based upon his long experience in the Federated Malay States. But Mr. Gilmore resigned his position after a few months, and his successor, Mr. G. C. Flower, took up the work in consultation with Mr. Reeves, whose health was then much restored.

Then in the spring of 1934 it was learned by the Secretary that the *Nautical Almanac* for 1935, not yet published, would contain further changes: the tabulation of Hourly Variation of the elements was to be abolished, and the simple first differences printed, with provision for interpolation to higher differences when necessary—an excellent change, but one requiring that all the principal forms of astronomical computation be again recast. It meant further delay, but

with the compensating advantage that the volume is now right up to date in its relations with the *Nautical Almanac*, which, owing to the valuable but frequent changes made in that work by Dr. Comrie during the last ten years, can be said of few text-books.

Nothing is more difficult than to print a computation form in a page so small as that of 'Hints to Travellers.' An immense amount of time had been spent in trying to fit the corrected forms into the page; and when the forms had to be again revised it seemed desirable to undertake a thorough reform, in the course of which the principle was adopted that the means of the micrometer readings should be taken and the corrections for level and refraction calculated and applied in the Angle Book. They were in method common to all observations, and need not be included in the computation forms special to the determination of latitude, or longitude, or azimuth.

It seemed also that the time had come to get away from the usual long tedious precepts for the different cases of sign, for north and south latitude and declination, etc. Strict attention to the algebraic rules of sign made it possible to avoid these complicated precepts almost entirely. With this simplification it was possible to design computation forms of uniform size 10×8 inches, to be written by a draughtsman and printed in green ink on blue-lined paper. The numerical examples required for the book were then written in Chinese ink upon the forms, and photographed down to the size of the page without loss of clearness. Six computation forms were thus produced, including one for latitude and longitude by position lines. It may be claimed for them that they are in their new shape much more legible than the old printed examples because the figures stand out from the explanations and precepts, and they have the considerable advantage that the blank computation forms may be purchased made up in blocks convenient for use in the field and the observations worked upon them in the field may follow precisely the arrangement of the examples in the book.

A great part of the chapter on field astronomy naturally follows pretty closely the canonical form of the standard methods in previous editions. It is necessary to mention here only the additions which have been made to the treatment. There is a new section on interpolation in the *Nautical Almanac* adapted to the new practice of printing first differences instead of hourly variations, and there is an explanation of the method of calculating second differences which one hopes is clearer than the rather complicated explanation in the *Nautical Almanac* itself. There are new sections on keeping the Angle Book, remarks on computation and checks upon the accuracy of observations designed to discover blunders. The section on Wireless Time Signals and Reduction of Comparisons by the Vernier Signals has been revised, with patterns of the principal signals taken from the R.G.S. Technical Series No. 3.

The principal addition is to the treatment of position lines, dealing first with the methods used at sea requiring special tables of different kinds, and passing to the methods not quite so short but much more straightforward by direct computation from the fundamental formulae. Many years ago there was a discussion in the *Journal* of the prismatic astrolabe methods, and it was remarked that the same methods might be used for reducing ordinary theodolite observations made in the four quadrants but not necessarily at constant altitudes. The principal difficulty in using the prismatic astrolabe is that the observer must prepare a programme of observations in advance. The extensive tables calculated under the direction and at the expense of Dr. Hamilton Rice provide admirably for the 60° astrolabe, and graphical methods have been devised and published for the 45° astrolabe introduced a few years ago into the Hydrographic Service. But it happens too often that programmes so prepared at the cost of

much time and trouble are nullified by cloud, and it is well to provide for working up the position lines that can be derived from sights upon any stars identifiable in the four quadrants. Computation form No. 6 has been devised for this purpose. The method makes the best use of a partially clear sky, and may serve also as a good introduction to the more accurate methods of the astrolabe which are fully described with examples and diagrams.

Finally, a new feature of the book is the method of computing refraction in extreme conditions by the aid of a diagram which gives the correction to the mean refraction when both barometer and thermometer are far from the mean, and when the simple arrangement of the tables hitherto given is no longer adequate. The method is intended particularly for reducing sights obtained in Polar conditions where there is often an inversion of temperature and no theory of refraction can give accurate results, so that elaboration is useless.

Chapter III on Instruments and Adjustments has been greatly changed to deal with the considerable developments which have been made in the instruments for surveyors since the Tenth Edition was published. The $3\frac{1}{4}$-inch Micrometer Theodolite has become the favourite instrument of the older type. The Wild Universal Theodolite, the Zeiss Theodolite, and the Tavistock Theodolite made by Messrs. Cooke, Troughton & Simms; the Prismatic Astrolabe for altitude 60° and Reeves Astrolabe attachment to the ordinary theodolite; the 45° Astrolabe designed for the Admiralty; the Sextant with reading tangent-screw and the bubble attachment to it; the Barr-Stroud Range Finder; the Bagnold sun-compass; and the Wild Photo-theodolite are all now included. There is a brief account of air-photography, including a pretty construction for reducing oblique photographs developed by Captain Desmond Crone, R.E., of the Survey of India.

Explorers in the now frequented Arctic regions have complained justly that the Tables in the older editions stopped short too often at latitude 60°; and that the tables for reduction of barometer heights had not sufficient range. This has been remedied in the new edition. All the tables having latitude for argument have been extended to the Poles; the barometer and refraction tables have been enlarged; and the new graphical method devised for refraction in extreme conditions. It was not possible to incur the expense and time of resetting the logarithm tables which have in successive editions been printed from plates. The rest of the book has been set in Monotype Imprint, 10 and 8 point, and should prove easy to read in the field.

In the Preface to this Edition the President has explained how it has come about that there is some diversity of style and treatment in the various parts of the book. The change in the *Nautical Almanac* made necessary considerable changes in the chapters on Field Astronomy. During the course of this revision it became apparent that other parts might with advantage be brought further up to date; and as the title-page states, there have been some additions and revision by other hands. But the changes have been made as unobtrusively as possible: so that as a whole the book shall stand as a monument to commemorate Mr. Reeves' long and distinguished service to the Society. A. R. H.

THE CHANGING SEA-LEVEL

THE CHANGING SEA-LEVEL: four Lectures given at the University of London in November 1933. By HENRI BAULIG. (The Institute of British Geographers. Publication No. 3.) *London: George Philip & Son* 1935. 10×7 *inches;* xii+46 *pages; diagrams.* 3*s*

THIS book contains four essays which formed the bases of a similar number of lectures given at the University of London in November 1933. Chapter I, "A Critical Retrospect," is a valuable statement of the implications and difficulties of studying past changes of sea-level, supported by a discriminating selection of bibliography. Attention is concentrated on eustatic changes with reference to Suess' deformational or diastrophic theory, its rejuvenation and restatement in more concrete form by Depéret and his "school," and upon "glacio-eustatism," which takes proper cognizance of the presumably inevitable and world-wide lowering of ocean-level, probably in excess of 100 metres during major glaciation of continental areas. Some wholesome and obvious corollaries of the last named, some stimulating home truths, and some wise advice to field geologists embellish an essay that all advanced students and their tutors should read diligently. The rap that the lecturer administers upon the knuckles of the Commission on Terraces of the International Geographical Union is misplaced, since some "rules" for which he has been looking were modestly suggested by its secretary in a pamphlet that he compiled and distributed in 1926. But if the lecturer can prepare "precise rules for the reconstruction and interpretation of fluvial and marine terraces" that are really fool-proof, he will earn the thanks and admiration of that Commission and of all geologists. He will find some of the difficulties in his own bibliography, notably among the classical analyses published by Douglas Johnson. Some workers in the field may not entirely agree with him in the predominance that he gives to erosional rock benches and the small part credited to constructional forms.

The second essay, "A new line of Research: the high levels of Erosion," opens as follows (the italics are not the reviewer's): "apart from terraces—whether associated with alluvium or not—representing ancient valley *bottoms*, the valley *sides* themselves, *when graded*, afford another basis for the restoration of former river profiles." One feels that there is some error of translation here, because terraces frequently do not represent valley bottoms: in a great river the actual bottom is usually sunk deeply below the flood plain, with or without constructional material, and outer margins of successive flood plains form erosional terrace features. Provided the valley sides receive reasonable rainfall they will become graded, with the progress of the erosional cycle, with reference to the floor of the valley. If a new flood plain is cut the valley sides may be graded to the new level. So, as the lecturer has shown in some of his well-known field work and brilliant papers, polycyclic valleys may be formed. By producing the curves of truncated profiles of the valley sides old positions of the trunk stream may be determined in the vertical plane. The same principle may be applied to the longitudinal profile. These methods have been applied sparingly by most students of river development and they are extremely useful within certain limits which M. Baulig takes pains to explain: if only students would keep within those limits they would do well. The author applies his principles with his usual skill and clarity of description to the platforms of lower Languedoc in particular, and passes on to consider the perplexing problems of the Pliocene marine levels in the Mediterranean. He applies his observations to the Paris Basin, with some interesting observations on pre-Pliocene regression and on the rate of upstream

erosion at this stage in Rhone and Seine, and concludes that there are at least "eustatic appearances" in the pre-Pliocene to Pleistocene platforms of erosion (whatever their nature). In this modest claim he will have general support: if the line of research can hardly be called "new" at any rate M. Baulig and his colleagues have given it new prominence and precision.

In Chapter III, "Interpretations," the author plunges into difficult country. He reviews briefly the possibilities of major uplifts of land having been caused by epeirogenic or orogenic movements, and finds both explanations to be incomplete; he therefore looks below the crust of the Earth for transference of subcrustal material which would hold the continents high and cause the ocean depths to sag low, with consequent adjustments of ocean-level. World-wide contemporaneity of such movements is assumed for purposes of the argument; but is it physically possible? It is a short step from such hypotheses to those of isostasy. Attention is drawn to the interaction of continental degradation by denudation and of isostatic elevation above former flotation planes as the load is lessened. M. Baulig points out that if the continents continue to rise erosion continues to cut down, and under these circumstances the continental planations so obvious to the eye could hardly be formed. He concludes that the interaction of erosion and isostasy cannot be so perfect as has been supposed, and that periods of rest—or interference from some other cause—must have caused isostasy to be approximate and intermittent. Chamberlin's observations on the power of the crust, under certain circumstances, to resist the pressure of a considerable overload are quoted, and attention is properly drawn to Dole and Stabler's work on the measurements of material transported by many rivers in the U.S.A. (and consequent rate of erosion of land). To these problems must be added, among others, the question of locating the common limit of the continental and oceanic segments: how much eroded material is in fact transported beyond the shore to the oceanic segment? M. Baulig concludes that erosion "obviously works at very unequal rates in different regions, its efficiency depending mainly on climate, relief, and rock resistance. Is it then likely that isostatic adjustments called into play through the progress of erosion will result in uniform rises of the lands, capable of simulating eustatic drops of the sea-level? The answer will depend on whether we conceive of isostatic adjustments as regional (or even local), or as continental." Can we "throw into the same structural unit the intensely and recently folded Alpine zone, the deep Mediterranean abysses, and the rigid Saharan platform" to explain "eustatic appearances" on the north and south shores of the Mediterranean? The author sympathizes with those who, at this point, "might feel tempted to throw overboard either isostacy or, more probably, eustatism"—or, one might add, both of them! With much courage he gathers up what remains after his bombardment and finds, among other things, that "*epeirogenic and isostatic movements* on the one hand and *eustatic movements* on the other, far from excluding each other, appear correlative," that "*all the major changes* . . . must be at least *approximately synchronous the world over*": locally the lands may have behaved in widely dissimilar ways.

The conclusions at the end of Chapter III may surprise some of M. Baulig's readers, so in Chapter IV he goes off "in search of more facts." He starts by warning geologists that they may mistake fault-line scarps for fault scarps and thereby post-date tectonic disturbances, and that stratigraphical errors may be committed in studying the deposits of rapid transgressions and regressions of the sea: the latter applies also to erosional features. He shows a decided preference for the results to be obtained from studying river profiles, and so we return to platforms of fluvial erosion and to Languedoc. The author gives brief sketches, based on his long experience, of the characteristics to be looked for in

supposed platforms of fluvial erosion: he discusses the functions of differential resistance and of the interaction of buried surfaces of erosion, re-excavated, with recent benches. Examples are given from the various parts of France to illustrate these and more involved points of initial difficulty. We are then introduced to statistical methods of analysing surfaces and to altimetric curves based on the frequency of spot heights. From these arise regional *series of levels*. The next problem is correlation between regions and here at last we are faced by the difficulty that all of us meet, even M. Baulig's friends of the Commission on Terraces! Correlation all too often carries a personal factor of credulity or scepticism: correspondence between whole series of successive levels may carry conviction, but they are exceedingly rare in nature; correspondence between main terms is all that we can usually hope for—is it sufficient? That, when all is said and done—provided the field work and statistical methods have been sound—is the rock on which the champions of causes epeirogenic, orogenic, eustatic, isostatic, glacio-eustatic, diastrophic, etc., stub their toes. "Truth in geomorphology," says M. Baulig, "is seldom more than increasing probability": all its students should read this closely written record of the long experience of one of its greatest masters. If in the field one can avoid all the pitfalls that he has seen, and if in the map room we can keep a sense of proportion, we shall achieve some useful groundwork: we shall not—or should not—find correlations till we know that regional workers are giving us truth, from which we can deduce the increasing probabilities. M. Baulig concludes his lectures with a question mark. If we continue the search which of his four extreme possibilities will become probabilities: (1) Total failure? (2) Eustatic appearances are mere appearances? (3) Eustatism is real but not universally verifiable? (4) Eustatism, except for very limited and distinctly unstable regions, is universally verifiable?

This long review touches upon all too few of the interesting contents of forty-six pages, the fruits of a lifetime in the field. Serious students must read them, but they must not be in a hurry. The Institute of British Geographers is to be congratulated upon their publication. K. S. S.

REVIEWS

EUROPE

STOCKHOLMS INRE DIFFERENTIERING. By H. W:SON AHLMANN, I. Ekstedt, G. Jonsson, W. William-Olsson. Meddelande från Geografiske Institutet vid Stockholms Högskola N:o 20 Stadskollegiets Utlåtanden och Memorial, Bihang Nr 51. 9×6½ *inches; maps*

This book is Part One of an economic-geographical investigation of present-day Stockholm and its suburbs. Part Three, 'Stockholm's Trade, Internal and Foreign,' was published in the same series in 1934, and Part Two, 'The Economic Geographical Development of Stockholm since the middle of the Nineteenth Century,' is to appear this year.

Part One deals with three main aspects in the development of Stockholm from 1910 to 1930. I. Ekstedt examines the distribution and grouping of official buildings, offices, and business premises of various kinds, and the principles which govern their position. G. Jonsson analyses the distribution of population and examines housing conditions in various parts of the city, and also gives some details concerning the day and night population. In an earlier chapter he gives a survey of foreign literature on the subject of town geography. W. William-Olsson contributes a detailed analysis of the localization and distribution of industry not only in the so-called "Stone Town" of Stockholm, the only part which is considered by Ekstedt and Jonsson, but also in the outskirts. This has been necessitated by the fact that industrial activity which is intimately connected with the city has been established outside its boundaries. W. William-Olsson also writes the final summary, which is in the main a repetition of the foregoing text with some conclusions and elaborations.

Except for some valuable tables of statistics, particularly those relating to industry, the whole book is little more than an elaboration and explanation of the eighteen excellent maps, which speak for themselves. Most of these illustrate phenomena not peculiar to Stockholm, but much evidence has been collected which would provide a solid basis for further study. There are maps showing the distribution of banks, banking-houses, stock-brokers, lawyers, offices, and city stores in the central parts of the city in 1910 and 1930, and a further number for 1930 only, which show differentiated enterprises such as furniture and linen shops as well as provision stores and other retailers. Of those dealing with population three show its distribution with regard to dwelling houses in 1910 and 1930, and two more illustrate Stockholm's importance as a place of work both for the inhabitants of the city itself and for persons travelling in every day from the outskirts. Finally there are three maps dealing with industry in 1930 and 1931. M. S.

PORTUGUESE SOMERSAULT. By JAN and CORA GORDON. *London: George G. Harrap & Co.* 1934. 9×5½ *inches; 312 pages; illustrations and sketch-map.* 10*s* 6*d*

Readers of the authors' earlier books will turn eagerly to their latest, and they will not be disappointed. The Gordon convention is to avoid as far as possible the spots well-known to tourists and to concentrate upon the life of town and countryside. The result is a real contribution to an understanding of Portugal and her people which should in the end prove of more value to the intending visitor than a formal guide. For several reasons it is difficult for the foreigner in Portugal to depart from the well-marked track, as the authors, in their inexperience, discovered upon their first visit. Cheap hotels are not generally to be found, so that in 1926 they were confined to a brief stay in Oporto and a

rather longer visit to a hydropathic establishment in the Douro valley, where their desire for roving was severely frustrated. They left consequently with a strong dislike of Portugal.

Seven years later, when the first disappointment had faded, and they had realized that their mistake had been in judging Portugal by the standard of Spain, they decided to return, and discovered the real attraction of the country—hence the "Portuguese somersault" of the title. This time they travelled extensively on foot and by motor bus in the south, around Lisbon, into the Algarve, and along the frontier. Their experiences with hotel keepers, gypsies, and all chance acquaintances make most amusing reading, for they have a happy knack of extracting the most out of all minor incidents, and not least from those that at the time appeared far from humorous.

They have naturally much to say of local arts and industries, of folk-lore and music. They encountered one local poet, of whose remarkable verse narrative of experiences in France they give a full and entertaining translation. Their black-and-white sketches, drawn with vigour and economy, add much to the attraction of this entertaining book. Each chapter preserves the fresh flavour of first-hand observation with the attractiveness of personal communication, and the humour never flags. In short, this is a vivid and enjoyable contribution to the lighter literature of travel. G. R. C.

SO YOU'RE GOING TO THE MEDITERRANEAN! By CLARA E. LAUGHLIN. *London: Methuen & Co.* 1935. 7×4 *inches;* xvi+644 *pages; illustrations and sketch-map.* 10*s* 6*d*

This coy title is the worst thing about the book, and is no indication of the excellence within. Its compact size is not the least of its merits, for the author is an artist and knows what to eliminate; in 620 pages of excellent print, with photographs and a map, Miss Laughlin has given us the perfect guide-book. Written with charm, wisdom, and erudition, it is eminently readable, apart from its practical functions. All important information on means and times of transport, hotels, restaurants, and prices, is included without becoming boring to readers whom these details do not concern.

With such a wide field to cover, it is obviously impossible to allow more than 35 pages at most to one place. Athens has 35, Venice 12, and Istanbul 6 pages, while many places of interest can only be spared a paragraph or two.

Miss Laughlin selects various historical incidents and personages from the daunting mass of material at her disposal, conjures up the past, and creates a vivid and characteristic atmosphere in every place she visits. Granada and the Alhambra are a background for the story of Ferdinand and Isabella, the Moors, and Columbus, told with imagination and economy. The Crusaders come to life in Syria. The author is a mine of information on the history of the latin races. Well read in relevant history she has both humour and tolerance.

Her twenty maxims for travellers and her views on the limitations which the tourist, equipped with more zeal than leisure, should set to his sightseeing, are rare in an American and very pertinent! If any one can peruse this book for long, without rushing off to an agency to enquire about ships and trains, it can only be through total lack of funds! E. N.

ASIA

THE BLACK TENTS OF ARABIA. (My Life amongst the Bedouins.) By CARL R. RASWAN. *London: Hutchinson & Co.* 1935. 9½×6 *inches;* 280 *pages; illustrations.* 18*s*

The author of this work is apparently a naturalized American of German origin

and evidently shares to the full the passion of his adopted fellow-citizens for glamour—particularly of the nocturnal and Arabian varieties. He gives us that in full measure and his photographs of animals, articulate and otherwise, are wholly admirable. If he has any serious interest in life, it probably centres on horses; and he succeeds in creating the impression that he knows more about them than anybody else. He has had the rare experience of securing from an Arab sheikh for nothing, so it would appear, a stallion for which he had expressed his willingness to pay a thousand golden sovereigns. We are evidently in contact with an individual of Lawrencian calibre, and we have only to regret that, Lawrence-like, he appears to have retired to the obscurity of a Californian stud-farm to escape the fame to which he is entitled for his amazing exploits among the Ruwala Badawi.

His book, excellently translated from the original German into English, falls naturally enough into the familiar category of *sheikh* literature. With suitable adjustments it would make a capital film, but serious students of Arabia will perhaps find it difficult to accept the story as a literal account of the author's actual experiences in the Trans-Jordanian and Syrian fringes of the Arabian desert. He makes no claim to have entered any part of Sa'udi Arabian territory; he never visited Jauf or even Kaf, as far as we know from the book; and he magnifies the desert post of Rutba into a town. Within the limits of his wanderings he claims to have "lived for the most part in quite unknown regions, never, or very rarely, visited by Europeans": but it would be tedious to enumerate the Europeans who must have seen and wandered over every inch of this desert between Tubaik and Euphrates.

Yet surely none of them can claim to have experienced a tithe of the adventures, pleasant and otherwise, which fell to the lot of Mr. Raswan. He appears to have achieved an intimacy with the Badawin women such as has rarely, or never, been accorded to foreign men: he has seen 300,000 camels march together for days on end over a drought-stricken desert: he has played heroic parts in the common desert pastime of mechanized raiding, for the tribes he knew so intimately have discarded the camel and the horse for Ford cars. And from one such encounter he, single-handed, extricated his dead or mortally wounded companions to the safety of a distant camp.

Altogether it is a breathless story which will doubtless give pleasure to romantic minds, but it is difficult to connect the catapulting incident of 1912—the very *fons et origo* of the whole story—with the young Amir Fawwaz, grandson of the redoubtable Nuri. Sultan, the elder brother of Fawwaz, was certainly not more than thirteen when his father died in 1921. Fawwaz himself could therefore not have been more than three in 1912, while there is reason to believe that he was a year or two younger than that.

Enough has been said perhaps to help a fastidious reader to decide whether to read the book or not. No single story in it is absolutely outside the limit of credibility, but one who has spent twenty years in Arabia may be pardoned for envying the author the gallimaufry of thrilling adventure that fell to his lot. And he writes about it all with all the sincerity of a modest man. H. St.J. B. P.

THE INDUS CIVILIZATION. By ERNEST MACKAY. *London: Lovat Dickson and Thompson* 1935. $7\frac{1}{2} \times 5$ *inches;* viii+210 *pages; illustrations and sketch-map.* 6*s*

It is little more than a decade since the researches of the Archaeological Survey of India revealed the existence of a great prehistoric civilization in the Indus Valley dating back to the third and fourth millennia B.C. and rivalling, and in some respects perhaps excelling, those of ancient Egypt and Babylonia. The

results of the first five seasons' excavations were described in the official account edited by Sir John Marshall and published in 1931 in three large volumes under the title 'Mohenjo-daro and the Indus Civilization.' Dr. Mackay, who was in immediate charge of the work at Mohenjo-daro for several seasons, gives in this handy little volume a summarized account, arranged on more popular lines, of the main features of this civilization, incorporating results of later excavations. His archaeological experience in Mesopotamia and Egypt has enabled him moreover to draw interesting comparisons and contrasts with these other countries. Architecture and masonry, religion, dress and ornaments, implements and tools, arts and crafts, and customs and amusements form the subjects of separate chapters. The evidence points to a highly organized society of peaceful character, widely engaged in trade, living in carefully planned brick-built cities, with elaborate systems of drainage and of public and private baths, skilled in the use of metals, including bronze, making fine wheel-turned pottery, often highly decorated, cultivating cotton, wheat, barley, and the date-palm, and employing wheeled carts for carriage. Perhaps the most distinctive and interesting of all the objects found are the hundreds of "seals" (possibly amulets) delicately engraved with various figures and inscriptions in "pictographic" characters that have hitherto defied attempts to decipher them.

Dr. Mackay cites several reasons for concluding that these ancient cities enjoyed a moister climate while they flourished. Has the rainfall over the whole area decreased, or did shifting of the river courses lead to abandonment of the old sites? If the latter, it seems not unreasonable, in view of the many recorded earthquakes in the region of Sind, to suggest that a prehistoric seismic convulsion may have been the cause. This would perhaps also explain the subsidence of walls and the contorted positions in which two groups of skeletal remains were found at Mohenjo-daro. C. E. A. W. O.

NORTH AMERICA

TO NOVA SCOTIA. By T. Morris Longstreth. *New York—London: D. Appleton—Century Company* 1935. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xiv + 290 *pages; illustrations and sketch-map.* 10*s* 6*d*

Mr. Longstreth seems to make a speciality of chatty guide-books to American and Canadian resorts; for he already has seven to his credit. His plan is to read widely about the history and geography of the locality he is writing about and then to work in this information in the form of conversational badinage. But although the bibliography printed at the end of this book is lengthy and complete, the author has not always seized the salient points of the books mentioned. For instance, in referring to the *Grand Dérangement*, as the dispersion of the Acadians is generally called, he omits to mention the fact so well brought out by Professor Brebner that Lawrence carried this out against the formal and expressed wishes of the British Government. The author's account of many out-of-the-way and curious places in this province is most entertaining and it is interesting to read that St. Paul's Church in Halifax is modelled on St. Peter's, Vere Street, London. History is of course hardly the author's strong point and his slips are numerous. John Cabot did land on Cape Breton Island where he saw notched trees and nets for catching game or fish. The idea that the Micmac chief Membertou ever saw Jacques Cartier is very far fetched, although Cartier did meet Micmacs in Chaleur Bay. On p. 46 De Sausase should be La Saussaye. Although Lescarbot's History contains six books, these were all in one volume, not six. Prince Edward Island was Ile St. Jean, not De Jean. Henri IV died in 1610, not 1611. The chapters on Haliburton and Howe are good, but one of the best stories on the latter is omitted. The distinguished

writer who bought his house used to give dinner parties ending with port "found in Sam Slick's cellar," although as a matter of fact it had been purchased from the grocer round the corner. The photographs are poor. H. P. B.

BERNARDO DE GÁLVEZ IN LOUISIANA, 1776–1783. By JOHN WALTON CAUGHEY. (Publications of the University of California at Los Angeles in Social Sciences. Volume 4.) *Berkeley: University of California Press (London: Cambridge University Press)* 1934. 9½×6½ *inches;* xii+290 *pages; portrait.* 13*s* 6*d*

In 1762, towards the close of the Seven Years' War, France ceded to Spain the town of New Orleans and the region west of the Mississippi that was known as Louisiana. The object of this cession was to prevent the country falling into the possession of the victorious English. Spain may have regarded the gift as a white elephant, but she accepted it because "she saw in it the means of insulating the rest of Spanish America against the English." For the following forty years Louisiana, whose European inhabitants were mainly of French extraction, was governed by Spanish officials. The volume here under review describes the work of the first Spanish governors, Ulloa, O'Reilly, and Unzaga, as a preliminary to its main theme, the governorship of Bernardo de Gálvez, who entered on his task in 1776. The new governor succeeded in reconciling the French to Spanish rule and encouraged trade, settlement and agriculture. External affairs were however of far greater importance than internal reforms, as Gálvez' tenure of office coincided with the American Revolution. While Spain was still a neutral, Gálvez gave considerable assistance to the Americans. After Spain had declared war on England in 1779 Gálvez personally conducted military operations against the English and captured the Gulf ports of Mobile and Pensacola. He was also responsible for the capture of the Bahama Islands, but his projected attack on Jamaica came to nothing. The author is of the opinion that Gálvez' victories had considerable effect on the terms of the peace treaties and that "the cession of the trans-Appalachian region to the United States was due more to England's loss of the Gulf Coast than to the prowess of American arms in the West." After the war Gálvez was moved to Mexico City as Viceroy of New Spain, but he died of fever in 1786 at the early age of thirty-eight. This scholarly work is based on very careful historical research, involving a thorough examination of manuscript sources, and is the first biography of this interesting man. It is to be regretted that the author included no maps, as they would have been a great help in elucidating Gálvez' campaigns. The book contains an index and a reproduction of a portrait of Gálvez. E. W. G.

CENTRAL AND SOUTH AMERICA

OFF TO MEXICO. By LEONE and ALICE-LEONE MOATS. *New York—London: Charles Scribner's Sons* 1935. 9½×7 *inches;* xviii+186 *pages; maps (by Matias Santoyo).* 18*s*

This is a guide-book written by Americans primarily for the benefit of the large class of motor car owner-drivers in the United States. Assuming only elementary knowledge of Mexico by the reader, the preface explains that the country is not dangerous for tourist travel, that railroads, roads, and 'bus-routes connect all the principal towns, and that, generally speaking, American film and Wild West impressions of Mexico are wide of the mark. Even the traditional revolutionists are said to be discouraged "owing to their inability to reach the high standard of lawlessness set by gangsters in the United States."

The authors are rightly enthusiastic over the picturesqueness and charm of

Mexico and its people, but some Mexicans might wish to qualify the statement that their country offers as complete a contrast to the United States as Central Asia. However our writers are not in a mood to brook contradictions: "This book is divided into 10 chapters, each dealing with a separate section of the country and we have taken in all the worth-while places. . . . A map accompanies each chapter with every church, monastery, pyramid or statue that should be visited indicated upon it and the routes are so well marked as to be practically foolproof . . ."

The maps first catch the eye, for they are many-coloured and of the style favoured by our forefathers; concentrating on the route traversed, with rude sketches of the landscape visible from it and all blank spaces filled by pictures of bull-fights, market scenes, Mexican rugs and embroideries, churches and other monuments. There are no contour lines giving the topographical relief, which is one of Mexico's chief features. For instance, a descent of 7000 feet from the Central Plateau to the coast-line of the Mexican Gulf is assumed to be sufficiently covered by separate tables of distances from Mexico City to points on the motor routes described, with occasional altitudes. An admirable précis of Aztec history is supplied with the assistance of the Mexican Department of Colonial Monuments, which has also presumably assisted with the very readable description and legend with which the touring directions are sprinkled.

A number of appendices point out clearly the official regulations necessary when entering and leaving Mexico: such as passports, Customs and baggage, cameras and films, and licences for touring automobiles. There is a list of hotels in the towns visited, "starred" in Baedeker fashion. There is also, somewhat surprisingly, a list of the artists of Mexico from the sixteenth century down to our own times. Unfortunately there is no corresponding list of Mexican writers or an Anglo-Mexican bibliography, which would have assisted after-study. But there is a list of the principal volcanoes.

The authors are realists. "Throw away the belly-bands and forget the advice," runs one memorable passage; "You can't go far wrong if you eat and drink and wear what the other inhabitants do. What they have managed to withstand for so many years probably won't hurt you"—which voices the sentiment of every foreigner resident in Latin America, who has suffered from the fads of tourist visitors. As to their own glossary of Anglo-Spanish words and phrases, "it should take you through Mexico without too many accidents. No effort has been made to make the phraseology elegant, or even quite correct; the object is to make yourself understood."

An admirable if somewhat bulky compendium for the sightseer who is provided with the necessary $4.00 to $8.00 (U.S.) per day for expenses, with a comfortable touring car and with good companions ready for adventure.

W. S. B.

AUSTRALASIA AND PACIFIC

TOURING IN NEW ZEALAND. By A. J. Harrop. *London: George Allen & Unwin*, 1935. 8½×5½ *inches; 296 pages; illustrations and maps. 7s 6d*

After eleven years in England Dr. Harrop returned in 1934 to New Zealand where he was convinced of the necessity of some book, of a more attractive nature than the usual guide-book, which would clearly and concisely present to visitors from overseas the many unique charms and beauties of New Zealand, and the best ways of seeing them. In eight months Dr. Harrop travelled some 8000 miles in New Zealand, covering the ground systematically and visiting all the principal tourist resorts and places of interest and the result is the work under review—a most excellently written and much needed book.

Divided into three parts, South Island, North Island, and General, the description of the South Island is very wisely placed first, "as most overseas visitors land at Auckland or Wellington," and "in order to emphasize the fact that nobody can claim even a superficial acquaintance with New Zealand until he or she has explored that favoured land of mountain, lake, and forest-fringed glacier."

It is true that visitors to New Zealand are almost always allotted a much greater proportion of time in the North Island, with a very cursory visit and insufficient time to see the beauties of the South Island.

With the history and relationship of Maori and white man as a background the author gives a very clear and detailed description of present-day touring in New Zealand. There are sections for those who may consider settling permanently in New Zealand's delightful climate, sections on curative springs, winter sports, angling, deep-sea fishing, deer stalking, summer cruises, air travel, clothes, food and local customs, and another on the wealth of trees and flowers peculiar to New Zealand.

Three specimen itineraries are given of tours of twelve, fifteen, and forty-four days, with approximate costs. There is also a list of books which may be read with advantage before or during a visit to New Zealand. Twenty-four excellent full-page photographs and maps of the two islands.

One can have nothing but the highest praise for a book which will be greatly welcomed not only by New Zealanders themselves, but by friends of New Zealand "at Home" and in other countries. It is *the* book which should find a place with every visitor to New Zealand.

If any one should ask me for advice regarding a visit to that country I should unhesitatingly say, "Get Dr. A. J. Harrop's 'Touring in New Zealand,' and take it with you." A. C. B.

POLAR REGIONS

FANGST OG FORSKNING I SYDISHAVET. By BJARNE AAGAARD. Tredje Bind. Antarktikas Historie. Første Del. *Oslo: Gyldendal* 1934. 10 × 6½ *inches;* 554 + LII *pages; illustrations and maps*

The first and second volumes of Mr. Aagaard's great book on the Antarctic dealt mostly with Norwegian work and Norwegian ships in the south. The third volume which has now appeared is the first part of a history of the Antarctic so thorough and complete that one looks in vain for the omission of any ship that up till 1840 went within sight of the southern ice. Opinions may differ as to the boundaries of the Antarctic regions: Mr. Aagaard takes the whole Southern Ocean for his province, not forgetting the Falkland Islands, Fuegia, and the outlying islands of New Zealand. A short general survey of the Antarctic with some discussion of nomenclature is followed by an excellent survey of Antarctic literature. Then the story of exploration begins with the ancient Greeks, touches lightly on the Dark Ages, dwells at greater length on the Age of Discoveries, and tells of Narborough, de la Roche, Bougainville, and many others till Cook is reached. All this is interesting but not new. Of more value are the chapters on early sealers in reference to Kerguelen, the Auckland Islands, Bouvet, Campbell, Macquaire, and many other islands. Here Mr. Aagaard's extraordinary industry and thoroughness are well exhibited. Nothing seems to have missed his net, and the pictures and early maps, excellent throughout the volume, are of particular value. Then the sealers press farther south and we reach the true Antarctic in the South Shetlands, the South Orkneys, and the Graham Land area. Bellingshausen and Weddell get lengthy notice. Even Morrell gets a chapter to himself. After Biscoe, Kemp, and Balleny, the

volume ends with some account of the search for Dougherty and other dubious islands but there is nothing new to say on this subject. A voluminous index adds to the use of the book, but apart from the numerous reproductions of old maps there is no general map in this volume. To be in a position to compile such an historical work without the dictates of a publisher as to space must be enviable and Mr. Aagaard has made full use of it, especially when he touches Norwegian interests in Bouvet and Peter I Islands. A portrait of Dr. H. R. Mill follows one of R. Amundsen as a second frontispiece. R. N. R. B.

SUCH IS THE ANTARCTIC. By LARS CHRISTENSEN. Translated by E. M. G. JAYNE. *London: Hodder and Stoughton* 1935. 9×5½ *inches;* 266 *pages; illustrations and chart.* 16*s*

Lars Christensen of Sandefjord here tells with epic vigour the story of the enterprise of a Norwegian commercial house in exploring and exploiting the South Polar Seas. The book is admirably translated and goes smoothly and strongly in its English presentation.

It is not clearly arranged however, the narrative of the author's three descents on the Antarctic regions being interrupted by long, though interesting, digressions recalling events of the past which led to his adventure, recounting the incidents of the expeditions on which he dispatched other explorers, and now and again foreshadowing exploits of the future. An index would help to keep the several stories distinct; but there is no index. The reader who wants to get full value must have the patience to read the book through twice, first to get a general impression of the place of whaling in the life of modern Norway and again to appreciate the full bearings of the facts as stated.

Mr. Christensen writes as a patriotic Norwegian, but he is careful to avoid hurting the susceptibilities of others, passing by certain thorny questions of priority of discovery or nomenclature as matters for arrangement through diplomatic channels rather than for controversy. This non-controversial treatment may at times suggest a one-sided view of the facts, as in the route-maps which adorn the end papers where only the names of Norwegian discoveries are shown. But due credit is given in the text to the achievements of British, Russian, French, American, Belgian, German, and Swedish explorers. It is good to see how fully the work of all predecessors has been studied and how largely it has been supplemented by men who are now reaping from the desolate South Polar regions the richest harvest the sea has ever yielded.

There are two impressive pictures left on the mind after reading this book, the rapid growth and enormous magnitude of the modern whaling industry and the outstanding character of two men, Christian Christensen who initiated and developed Antarctic whaling, and Lars Christensen, his son. The two stories are intertwined and lit by flashes of vivid autobiography. While honouring the men who took opportunity at the flood which led them on to fortune, I cannot but cast a backward glance of regret to the day in 1892 when I sailed down the Tay on the *Balaena* after handing over the equipment of special instruments for navigation and scientific observations provided by the Royal Geographical Society at the instance of Mr. B. Leigh Smith for use in the Weddell Sea. The "little more" that might have made that venture of the four Dundee whalers as sure "a potentiality of wealth beyond the dreams of avarice" was not forthcoming. Two seeds were planted that year in the same pot, the British was withered as it put out its first leaf, the Norwegian has grown into a monarch of the forest.

Lars Christensen was a boy of eight in the summer of 1892 when his father charged C. A. Larsen, the master of the Norwegian whaler *Jason* (p. 20), "to

bring back in the *Jason* that golden fleece which had for centuries been hung up to dry in the depths of the whaling-bank."

The *Jason* went back to the Weddell Sea in the following year with two other Norwegian ships, and as he grew up Lars Christensen lived in an atmosphere of Antarctic talk, surrounded by stuffed penguins and the skulls and skins of southern seals. He was just coming of age when his father initiated pelagic whaling by sending out the factory-ship *Admiral* to the South Shetlands in 1905, and he followed every incident in the development of a technique suited to the severe conditions and the distance from markets of the ocean bordering the Antarctic floes. The father built up a great industry; the son when in 1907 he visited New Bedford, the centre of American whaling a hundred years before, definitely resolved that he must go out and see for himself what the Antarctic is really like; but twenty-three years were to elapse before he could gratify this ambition. In due course he succeeded his father, in whose memory he founded the important Whaling Museum at Sandefjord, and at last he was able to give effect to his view that exploration and the acquisition of new lands for Norway should lead to a still greater development of what had become a staple industry of his country. So he equipped the *Odd I.* expedition to Peter I. Island and the *Norvegia* expedition which landed upon that remote outpost and on Bouvet Island, annexing both to Norway. He urged successive explorers in the *Norvegia* to visit Enderby Land, and to discover new stretches of the Antarctic coast in nearly continuous succession westward to Coats Land. All this is part of Antarctic history, and Mr. Christensen refers readers for full details to Mr. Bjarne Aagaard's monumental treatise on Whaling and Exploration in the South Polar Seas, where by far the fullest and most richly illustrated records of Antarctic exploration are to be found.

At last Mr. Lars Christensen and his intrepid wife felt that the time had come when they might see for themselves that promised land of "floe and snow and blow," and it is the personal record of the three trips they made which gives the human touch and vital charm to this volume.

The voyages were made in the great oil tanker *Thorshavn*. This vessel regularly visited the various factory ships of the firm strung out on the edge of the ice, supplying them with fuel-oil and receiving in return the whale-oil extracted by them from the carcases brought in by the little catchers, several of which served each of the great factory ships.

The first voyage started from Cape Town on 6 January 1931, and Lars Christensen had his first sight of the Antarctic continent on February 5 when he reached Enderby Land just a century after its discovery by Biscoe. On February 19 he was back at Cape Town. He kept no diary on this trip, and the record is brief.

The second voyage was more ambitious, the party which accompanied him was larger, and several members kept diaries from which there are graphic transcripts. They left Cape Town on 25 January 1933, went to Enderby Land, encountered many perils of storm and fog and ice, made several adventurous trips in whale-catchers, and both he and his wife had the thrill of shooting a whale with the big harpoon gun on the bow of the tossing ship. He also tried successfully a new method of killing whales by electricity. The return was made by Bouvet Island, Gough Island, and lastly Tristan da Cunha, of the landing on which there is a delightful account. The party left the tanker at Rio de Janeiro.

The third journey was more ambitious still. On it Lars Christensen and his wife were accompanied by their eldest son, thus introducing the third generation to the Antarctic. The main object of this cruise was the investigation of new

whaling grounds, and a certain reticence is naturally observed as to what was seen and where. Leaving Cape Town on 30 December 1933 the *Thorshavn* made for Enderby Land and thence eastward near the Antarctic Circle, and sometimes within it, often in wireless communication with Admiral Byrd at Little America. They reached 71° 44′ S. to the east of King Edward Land in 131° 11′ W., the highest latitude ever attained near that meridian. The ship went on, nearly circumnavigating Antarctica, passing close to Peter I. Island and northward to Cape Horn, reaching civilization again at Monte Video.

Altogether the record is one that stirs the imagination of any one with a mind attuned to the romance of modern exploration. One cannot but compare the realization of well-laid plans through the immense resources of the whaling magnate of to-day with the failure of the equally enlightened efforts made with small means and poor results by his prototype Charles Enderby, who tried so hard to establish Southern whaling a hundred years before. H. R. M.

PHYSICAL AND BIOLOGICAL GEOGRAPHY

EARTHQUAKES AND MOUNTAINS. By HAROLD JEFFREYS. *London: Methuen & Co.* 1935. 7½×5 *inches;* x+184 *pages; illustrations and maps.* 7*s* 6*d*

To a large extent this volume is a summary of the author's well-known book 'The Earth,' and it will be welcomed by many who, in reading the latter, have felt rather out of their depth. They need not fear that it will be so with this summary. Close attention may be necessary but the author has been successful in putting difficult discussions into a simple form. There is little about the astronomical matters dealt with in the larger book, but there is a good deal about other work which has appeared since it was published.

One of the most interesting chapters is that on earthquakes, in which it is shown how earthquake waves give information about the interior of the Earth. In 1906, from the behaviour of earthquake waves at a great distance from the origin, R. D. Oldham proved that the core of the Earth, occupying nearly a half of the whole diameter, must be very different from the rest. The subject has been greatly developed since then.

Dr. Jeffreys has always been a supporter of the contraction theory, which is the only one that provides stresses sufficient to cause the elevation of a great mountain range. The chief valid objection to it was that the amount of lateral contraction indicated by the folds and overthrusts in mountain regions was greater than could be accounted for by thermal contraction of the interior. The estimates of lateral contraction rest on very imperfect evidence and, indeed, depend largely upon hypothetical reconstructions. They may be right, but it would not be surprising if most of them were altogether wrong. However this may be Dr. Jeffreys in his last chapter gives an interesting suggestion which he made four years ago and which accounts for these great overfolds without involving any excessive contraction of the interior. P. L.

STRUCTURAL GEOLOGY, with Special Reference to Economic Deposits. By BOHUSLAV STOČES and CHARLES HENRY WHITE. *London: Macmillan and Co.* 1935. 9×6 *inches;* xvi+460 *pages; illustrations and maps.* 25*s*

This is an English translation and elaboration of a work originally published in Czech and in German. Primarily intended for the instruction of mining geologists, mining engineers, and allied technicians, it should prove a useful work of reference to geographers concerned either with the tectonic or with the economic side of geography. Clear, succinct statements and a wealth of illus-

trations—photographs, maps, and sections—make it an excellent guide to the rather complex subject of rock-structures. The primary structures of rocks occupy the first quarter of the book; structures due to orogenic movements occupy most of the remainder, and there are short sections on geological mapping, geophysical surveying, and mining practice, as well as a glossary (not entirely satisfactory) and a bibliography. A. M. D.

CARTOGRAPHY

A MARINHARIA DOS DESCOBRIMENTOS. By A. FONTOURA DA COSTA. (Bibliografia Náutica Portuguesa, até 1700.) (Separata dos "Anais do Club Militar Naval.") *Lisboa: Imprensa da Armada*, 1933. 10×7 *inches;* 512+x *pages; illustrations and maps.* 200 *escudos*

Europe is displaying an almost senile curiosity in the details of its biography so that much attention has turned on the dramatic discoveries which initiated the centuries of European expansion. Modern interest centres no longer on the melodramatic aspects of the great discoveries as a romantic theme. In England Professor E. G. R. Taylor has examined the ideology of the movement and put into perspective the geographical ideas of these times. Fontoura da Costa in this new book presents a similar analysis of the technique of navigation at the beginning of the discoveries and the changes brought about in seamanship by the enormous field of experience opened up. Da Costa confines himself to Portuguese materials; and justifiably, for Portugal in navigating matters made its greatest contribution to European development.

While the author, true to his plan of making a scientific survey of a scientific matter, carefully avoids being side-tracked by the misty details of personal biography, he begins with a fitting tribute to Dom Enrique, Prince Henry the Navigator as we know him, whose individual influence gave the great impulse to Portuguese seamanship. "Of brilliant intelligence, allied to an almost Britannic energy and cold persistence, hard, practical, bold, he was the motive force of Portuguese discoveries." He collected the nautical instruments and documents then known and invited the "astrologers" of Europe to visit Portugal and impart their knowledge and maps. His appointment of the Mallorquin Jácome de Maiorca (1423?) to teach his science of navigation, maps, and instruments to Portuguese pilots was particularly important. Furthermore he established a training base in Lagos Bay whence sailed nearly all his expeditions of discovery and whither came most ships returning from long trips to pay their dues, to pass on their experiences, and to deposit their *roteiros* or log-books. Here in "A Casa da Africa"—later da India—accumulated nautical manuscripts and maps which would be beyond price if the Inquisition, the fire in 1745, and surreptitious acquisition by individuals had not practically reduced it to nothing. Two of these would throw much light on the ideas of the Discoverers—'Secret of Secrets of Astrology,' by Prince Henry himself, belonging later to Fernando di Colombo, son of Columbus, and Prinçe Pedro's own log-book.

Da Costa traces three distinct stages in the development of Portuguese navigation; adolescence, youth, and maturity of the science, or, as he describes them, A Marinharia (seamanship), O Arte de Navegar (art of navigating), and Sciência Nautica (nautical science). Such a classification, while by no means sharply defined in its limits, appears very reasonable and serves to illustrate the scope of this whole work which confines itself to the two earlier stages. Roughly, the stage in Portugal lasted from Prince Henry to mid sixteenth century, merged then into the second stage, maintaining its character fairly uniformly until the middle nineteenth century, when modern nautical science with its instruments of pre-

cision, its mathematical methods, its tables, maps, and charts became well established.

The difficulty with any study of the early stages must lie in the limitation of materials—sailors are at no time ready with the pen; the earlier lore was very probably more extensive than study of the written material reveals. Hence da Costa's original materials for the first stage are no more than thirteen old prints or manuscripts, generally Portuguese, although scattered as far apart as Munich and Paris. These thirteen sources begin with Zacuto's 'Almanach Perpetuum' of 1496 and end with João de Castro's 'Roteiro de Goa a Suez' of 1564. The lavish reproduction of elements contained in these sources so difficult of access to most English research workers should make this book invaluable and lend much help in the study of Portuguese influence upon contemporary English seamen.

The author's method is logical; taking some basic process of navigation, such as the rules regarding the Pole Star, for example, he traces the development of it as exhibited in the sources under examination. He thus brings into perspective the whole range of his materials. His chapters treat in detail the history of the various nautical instruments, of the methods of position finding at sea, of rules for sailing by compass, of sailing charts and tides, and of the changes made in old rules by the revised calendar. Finally the study extends beyond the first stage, as defined by the author, and continues with a much more extensive Portuguese bibliography to 1700. Why he chooses this arbitrary date to limit his study is not evident, and the author himself does not expand the point. The eighteenth century did not begin with some revolution in seamanship and does not end one of the periods defined by da Costa. We can only suppose that he takes 1700 to end approximately half of his "Art of Sailing" period, sufficient, that is, to permit us to see development from the first stage to the more mature. Thus the subtitle to the book is 'Portuguese Nautical Bibliography to 1700.' The bibliographical side of the book is excellently done: it catalogues, dates, discusses and gives present whereabouts to 123 manuscripts, 47 books, and 25 Portuguese versions of foreign books, all dating before 1700 and if not by, at least produced under the auspices of Portuguese. That the number of manuscripts should be so great is due to the *roteiros* or log-books which are carefully noted. (See article by Boxer on the *roteiros* in *Mariner's Mirror*, April 1934.)

Undoubtedly the greater number of nautico-astronomical problems were stated and solved, as soundly as the means of the time permitted, by Portuguese. This detailed study allows us to sum up more precisely the contribution of Portugal to navigation. In the matter of instruments they adapted the astrolabe and quadrant for use on board and gave the fundamental idea for measuring fractions of arcs (Pedro Nunes). Most of the principal methods of determining position were devised by Portuguese and, what ranks of utmost importance, advance to the formulation of tables for the purpose. With the mariner's compass, they laid down what variations must be allowed for, drew up the first tables of solar amplitude almost to the condition used to-day, endeavoured to determine longitudes by compass variations and sketched the first isogonal chart. Nunes made the first study of the loxodrome and maps *a proposito*. The custom of writing detailed log-books (*roteiros*) accumulated a mass of seafaring information such as few other nations can boast. As the author finally says, "We must state our most sincere admiration and respect for those pilots from the fifteenth to the seventeenth centuries, many of them without any learning, who with only the roughest and scarcest means of navigating, were able to shock their world by daring voyage and monumental discovery, the fruits of which, to-day, we all, in some way, enjoy."

The general arrangement of this book is highly creditable and scholarly: the text is amply annotated and the author, while giving the original forms from his sources, has ably expressed many of the involved descriptions of method into modern mathematical statements which are easier to assimilate. Many facsimile reproductions from manuscripts are given with a clarity creditable to modern Portuguese printing: it is the more regrettable that the binding of so weighty a volume should be faulty. At the end of the textual analysis is a detailed bibliography subdivided chronologically. The sole defect of this otherwise excellent study lies in the omission of an adequate general index for rapid reference. In total, da Costa's work must be highly recommended both to those interested in the flower of Europe's discoverers and to those interested in the early evolution of nautical science. E. H. G. D.

ECONOMIC AND HISTORICAL GEOGRAPHY

A ECONOMIA DO MAR. By ARMANDO GONÇALVES PEREIRA. *Lisbon* 1932. 6×9 *inches;* 452 *pages; illustrations and maps*

It is fitting that a country with such a distinguished maritime history as Portugal should produce this economic study of the sea: more fitting still that the work should be done by the newly set up Universidad Tecnica of Lisbon which conducts an economic department on the lines—if not the scale—of the London School of Economics. In his position as Professor of Economic Geography there, Gonçalves Pereira ranks easily among the first six Portuguese geographers of to-day, so that his work, which he rightly confesses to be incomplete despite its amplitude, has the guarantee of wide vision and ample training, developed mostly under the influence of French geographers.

No book of this size however has the right to group one-fifth of its contents as introduction, least of all when that introduction contains the most provocative matter of the book. Here the author traces the sea's importance in the national life and historic development of Portugal, examines the theories of human geographers (Ratzel, Brunhes, etc.) on the value of the sea in forming states, and summarizes the ideology of modern Portuguese writers on the subject. Here we must make it clear that Portugal has at the moment a National Government and is experiencing an intense wave of nationalism. This reflects in the point of view of the author, who accepts or refuses the theories according as he can or cannot adapt them to the special circumstances of Portugal, and support his idea of Portugal and its colonial possessions as a natural state-unit. Portugal lies between two dangers. In the Peninsula any movement towards Federalism jeopardizes the complete independence of Portugal; abroad, the colonies of a small power are overshadowed by the obvious dangers. We cannot then be surprised by the vigorous campaign—both direct and indirect—to emphasize the unity of Portugal and its colonies and a commercial policy which works to make the parts economically dependent on one another.

On p. 476, speaking of this unity, the author says, "Sua razão de caracter geografico, facil de determinar dentro dos conceitos da geografia moderna, constitui uma lei natural que certamente teria sido previsto pelos eminentes geografos das descobertas y conquistas." That one sentence exemplifies the extreme controversial character of points raised. Does modern geography clearly conceive what conditions give rise to a State? Is the question one which falls within the province of geography at all? Is there a "natural law" in state formation? Can it possibly be maintained that those practical-minded sailors of the Discoveries set out with the formed concept of amplifying Portugal into the "perfect" state by adding colonies? Undoubtedly there can be no harm in assuming a point of

view on these matters. What we must question is the right to include the thesis as a disproportionate introduction to an 'Economy of the Sea' which expects to claim attention for its impartial accumulation of fact and factual judgments. We must thank the author however for letting us know in summary what various modern Portuguese geographers have said on these matters.

For the rest, the main body of this book is divided into three parts. The first briefly sketches the function of seas in their physical effects upon surrounding land-masses and also the bio-geography of the oceans. Here the sketching is rather too brief and we feel again that the author hurries too much in his anxiety to include even here comments upon the sea's relations to national foreign policy. With the second part, scientific values show more prominently when Pereira treats of the sea as means of production. One-quarter of this chapter analyses broadly the various fishing zones, the character and relative importance of fishing in the principal countries and sums up the economic values of chief species of fish. In the other three-quarters he discusses fishing in its Portuguese setting: here we have the section of greatest interest to foreign readers, since its materials are quite new and much light is thrown on a little-known side of Iberian economic geography. Here the author shows full command of his facts, and he has had access to official statistics rarely seen in print, so that in this more sharply defined field he can view clearly economic perspectives.

In his third section Pereira remains still on more concrete ground: he studies the value of the sea in the geography of circulation. After treating of the world sea-ways and of the range of circumstances conditioning the rise of a seaport as illustrated by important foreign examples, he gives an extremely illuminating section on the sea as Portugal's main means of circulation, followed by a detailed discussion of what influences can be seen operating at the main Portuguese ports.

There is a diminutive fourth part of some dozen pages in which the author finds that his material on Portuguese maritime policy has already been exhausted in his enormous Introduction. Finally we have, instead of the far more useful index of materials, a hundred "Conclusions" which summarize the national policy recommended. The omission of an index is much to be regretted, and even more deplorable is the omission of a detailed bibliography. Merely to quote and acknowledge by footnotes hardly repays the efforts of other writers and definitely hinders those who wish to amplify what Pereira says. Moreover these footnotes often leave much to be desired: for example "Neroligia" suggests an illness rather than "Marion Newbiggin" whose 'Modern Europe' is being quoted, and the error can hardly be put down to the long-suffering printer.

This large book, like so many technical books in the Peninsula, has been privately printed. Economic or geographical texts seem never to be printed as a commercial proposition. The author probably intends to sketch for his University students the maritime aspects of modern European thought on economic geography. Its basis as a course leads naturally to the prominence of Portugal in its perspective, and it is a pity that highly controversial points are laid down so dogmatically that the book often succumbs to its tendency to pure politics. Foreign readers will nevertheless find in its pages extremely illuminating material on the question of Portugal in its relation to the sea. E. H. G. D.

CLASHING TIDES OF COLOUR. By LOTHROP STODDARD. *New York and London: Charles Scribner's Sons* 1935. 8 × 5½ *inches;* 414 *pages; sketch-map.* 10*s* 6*d*

In spite of its flamboyant title this is an interesting and important book, which deals mainly with the effect of modern Western civilization on other than occidental races. In the prologue, which is entitled "A World in Disintegration,"

the author points out that Western mechanical civilization, which is largely materialistic, has spread over the whole Earth; that in the clash of idealism with economics we find the seed of future trouble; and that some kind of world-order is obviously needed. The effects of Western technique have been more disruptive in the East than in the West. Finally man himself remains unchanged in a transformed world. After this introduction, which sets the tone of the book, we have a series of discussions of the chief factors in our present disturbed world-state, the first of these main divisions of the subject having the title "The Lost Comity of the West."

The author's thesis is that the former European solidarity was due to a general community of ideals, derived from Greece, Rome, and the Christianity of the Middle Ages, and that this community may be said to have lasted from about the year A.D. 1500 to the outbreak of the World War. Throughout the nineteenth century the sentiment of West-European unity was a strong one. West Europeans were the salt of the earth; "men like Havelock, Nicholson, and Gordon . . . felt themselves engaged in something like a divine mission." But two centuries had not sufficed to bind Russia intellectually to Europe. He thinks that the rulers of that country "want to take over the purely material aspects of our . . . civilization whilst rejecting the cultural and spiritual basis from which it has sprung."

There is a valuable chapter on "Disrupting Latin America," full of interesting facts and comments. Thus, Indianism in Mexico "means a deliberate repudiation of everything white." The objective of Indianism is the reversion to the pre-Spanish state. As to Brazil, the mixed races in that great country show the same temperamental features as some of the races of Spanish America. But a centre of effective power "is the block of stable, progressive nations in the extreme south, Argentina, Chile, Uruguay."

In another chapter the author deals with "France and the Black Power," and he paints in strong colours the dangers concealed in the policy of using black troops in European wars. He quotes General Mangin who tries to justify the use of Senegalese troops to fight for France. To supplement French man-power the General Staff maintains in France itself a garrison of tens of thousands of colonial troops, many of these being Senegalese. "The story of Imperial Rome thus tends to repeat itself." On the larger issue the author says that he looks forward to a white-Western comity in which "the peoples of Continental Europe, the British Commonwealth of Nations, the United States, and the genuinely Westernized portions of Latin America will all partake in a common life." He is not very kind to the League of Nations, and makes the best case that he can for the desertion of the League by the United States; but the case is not a very strong one.

Turning to the tremendous issues resulting from the impact of Western ideas on the life and culture of the East, he has much of great importance to say. This impact has tended to discredit the art and literature of Eastern peoples, "besides weakening allegiance to their religious beliefs and practices." The first reaction is an acceptance of Western science and technology and a rejection of some of the deeper and more essential elements of Western culture. In the political sphere we find a marked failure in the attempt to apply Western methods in China; in that country chaos reigns, and the high hopes of the young men educated in Europe and America have been grievously disappointed.

From time to time Mr. Stoddard touches upon that very fundamental difficulty of India, Japan, and China—over-population. The introduction of Western ideas and methods has resulted in the abolition of those checks by which the numbers of the inhabitants were kept within reasonable limits. These checks were the high

death-rate, epidemics, famine, and infanticide. In Japan the quest for foreign markets is caused by the spectre of over-population. The climates of Korea, of Manchukuo, or of Formosa, do not suit the Japanese. The countryside of Japan is saturated with humanity, and the annual increase is of the order of a million a year. The problem is a vital and a very present one. The author compares the condition of a French farmer, with an average of two children, with that of a Japanese farmer with four or five children and only one-sixth of the land which a French farmer has. The old self-sufficient Japan had about thirty million people; to-day, Japan has something like sixty-six million. Japan simply cannot feed herself out of her own resources.

We do not find things much better in India, indeed it is probable that the Japanese peasant is better fed than the average Indian peasant. On the figures of the last two censuses it would appear that the population of India is increasing at the rate of three millions a year. The Indian is under-fed, and lives a short life; the expectation of life is decreasing. Mr. P. K. Wattal, whose important book 'The Population Problem of India,' was published during the War, is quoted by Mr. Stoddard, to show that the primary cause of the over-population of India is early marriage and the resulting very high birth-rate. And, as regards any possible escape in the direction of industrialization, Lord Zetland's view is mentioned, "I find it difficult to escape from the conclusion that the organization of industries on the lines evolved by Western nations is something which is altogether alien to the genius of the Indian people." The chapter on India is one of the best in Mr. Stoddard's book; it is well-informed, well-balanced, and impartial. He pays tribute to the immense benefits which have been conferred on India by British rule, and bears witness to the efficiency and honesty of the rulers. He analyses that remarkable condition of things under which more than 350 millions of Indians are guided and governed by a few hundred British civilians, backed by 65,000 British troops, and he adds that if these troops were to quit India it is a practical certainty that there would be, in a very short time, "a colossal dog-fight . . . Hindus, Moslems, Sikhs, Gurkhas, . . . would be at one anothers' throats. . . . India would revert to anarchy." And . . . if Gandhi's advice to scrap Westernism is taken, "untold millions would be doomed to speedy death from starvation."

What can exorcize that spectre of over-population, due to a social system which encourages reckless breeding?. It is for Indians themselves to grapple with that great evil.

The book is packed with information and wise comment. The Epilogue thus sums up the main thesis, "All mankind, with its wide distinctions of temperament and tradition"—and, a geographer might add, its large variations of environment—"is faced with the necessity of adapting itself to a way of life evolved by a single branch of the human species." C. F. C.

THE EXPANSION OF EUROPE. Fifth Edition; revised and enlarged. By RAMSEY MUIR. *London: Constable & Co.* 1935. 8×5 *inches;* xii+326 *pages.* 8*s* 6*d*

Mr. Ramsey Muir's lucid and suggestive essay on the rise of the nations of Western Europe to the status of world states and their relationships with the non-European races has gone through five editions since its appearance as a "war-time" pamphlet in 1917. Its utility, of which this popularity is sufficient evidence, is increased by the inclusion in this edition of a long chapter on the post-war years, in which the main tendencies are clearly indicated. The new matter falls roughly into three divisions, the League and the Mandatory system: the dissolution of the unity of Islam and the rise of westernized nation states in Western Asia; and the constitutional and economic development of the British

Commonwealth and Empire. If the ideal of collective action by the nations of the "interdependent world" has not been realized in full—and the author makes several critical points forcibly—the story he has to relate is not without its hopeful side. Many of the factors which have disturbed their relationships are common to the present state of world affairs in general. Except perhaps in the Far East, some progress had been made in solving the problems with which this book is concerned.

It is natural that the standpoint of the writer is that of the British Empire. There is no statement of French colonial administrative policy in comparison with that of Britain, and something might have been said of the position of the native races of Africa under the various European administrations. The author has performed a considerable service in outlining so clearly for the general reader the origins and development of the problems which face the Powers of Western Europe in the world to-day. G. R. C.

THE MARCH OF MAN: A Chronological Record of Peoples and Events from Prehistoric Times to the Present Day. Edited by LAWRENCE H. DAWSON. *London: The Encyclopaedia Britannica Co.* 1935. 12×9½ *inches;* 22+96+94 +[vii]+64 *pages; illustrations and maps.* £2 12*s* 6*d*

This volume marks a praiseworthy attempt at a new departure in reference works. It consists of a historical atlas in colour composed of maps from the various atlases of Messrs. George Philip and Ramsey Muir, seven large folding chronological charts covering world history in varying degrees of detail from 5000 B.C., and a photogravure section of sixty-four plates depicting persons and events, generally as recorded by their contemporaries. This scheme is evidence of the extent to which the unity of the world has become a commonplace in the popularization of history, in contrast to the "insular" standpoint of the older text-books. It is also a welcome sign that the publishers anticipate a popular demand for a good historical atlas, certainly superior to any school atlas at present in circulation.

The mere juxtaposition of events in chronological columns cannot of course bring out definitely their connection and interaction: to take an example at random, the invention of the internal-combustion engine, the consequent demand for supplies of oil, and the reaction of this demand upon the international politics of the Middle East, cannot be gathered from such tables. However the charts at least provide the student with material upon which to work, and, by a typographical device, serve as a systematic index to the *Encyclopaedia Britannica*. Within the space available, the illustrations cover political and military history reasonably well, but art, except incidentally, and science are unrepresented. Marco Polo is stated to have reached the shores of the Arctic Ocean, and the drawing from the Catalan Atlas is definitely said to represent the Polo caravan.

Despite its price—which however is reasonable considering the manner in which the technical difficulties of production have been tackled—the 'March of Man' should prove a useful addition to reference libraries. G. R. C.

GENERAL

WHERE THE CLOUDS CAN GO. By CONRAD KAIN. Edited by J. MONROE THORINGTON. *New York: The American Alpine Club,* 1935. 9½×6 *inches;* xxii+456 *pages; illustrations.* $3.00

This is a remarkable book written by a mountaineer who has a real genius for description and sustained narrative. Conrad Kain was born in 1883 in the village of Nasswald near Vienna. The Alps and the stories he heard about them were his

only heritage and they dominated his life from the beginning. Mr. Monroe Thorington, his translator and friend, claims that Kain alone has succeeded, where many other guides have failed, in recording the human relations of mountaineering. The fact is all the more remarkable in one whose career in the Alps was over before he was twenty-six years old. Kain acquired for himself a considerable reputation in the Alps and in British North America his first ascents exceeded sixty in number. He made new climbs in Corsica and had ascended some of the most difficult peaks in the Alps. In New Zealand according to his own count, fifty-nine ascents were to his credit.

Kain seems to have possessed every attribute which makes for an efficient, reliable guide and an agreeable, amusing companion. He was modest, too; "I am better than some, and not so good as others," he was once heard to remark. He was widely travelled, and gives entertaining accounts of his adventures; it is evident from these accounts that he made good use of those methods by which he declared a guide might hope to maintain the confidence of his party. "Firstly, he must never show fear; secondly, he should be courteous to all and always give special attention to the weakest member of the party; thirdly, he should be witty and able to make up a white lie on short notice, telling it in a convincing manner; fourthly, he should know when and how to show authority; and when the situation demands it, should be able to give a good scolding to whosoever deserves it."

Kain became a naturalized Canadian and married in 1917. Canon Sloman says of him: "I hope Conrad's married life was as happy as it deserved to be. But somehow I don't think he could ever have given his real heart to any woman. The mountains were his love and his life." C. F. M.

AS THE FOREIGNER SAW US. By MALCOLM LETTS. *London: Methuen & Co.* 1935. $7\frac{1}{2} \times 5$ *inches;* xii+282 *pages; illustrations.* 8*s* 6*d*

This selection of impressions recorded by foreign visitors to England and Scotland from 1500 to 1830 comes as a welcome change from the many recently published books on modern England by foreign authors. Mr. Letts makes a careful selection from a large quantity of material. He purposely omits any but passing reference to the letters of such prominent visitors as Voltaire, Chateaubriand, and Madame de Stael, and prefers to quote from lesser-known authorities, whose works are more difficult to obtain. He avoids any temptation to enter the realm of the historian, and confines himself exclusively to pictures, anecdotes, and criticisms of society with its amusements, fashions, prejudices, and peculiarities. No attempt is made to cloak the darkest side of English life and character; unqualified disapproval is more acceptable to him than unjustified admiration. In some cases Mr. Letts would appear to grant the foreign critic too much licence, but in so doing he is mindful of the proverb: "Qui s'excuse, s'accuse!"

Mr. Letts is to be congratulated on providing in so small a space such a large picture of customs and life in England; a picture which is most entertaining for the ordinary reader, and which, at the same time, opens up a wide field of study for those who wish to examine the subject in more detail. A number of illustrations from contemporary drawings are included, and certainly one of the most interesting of these is that of the Isle of Staffa by Faujas de Saint Fond, who was the first geologist to visit Fingal's Cave.

Many of the criticisms of English character are similar to those levelled against us by foreigners to-day. We are told that we are bad linguists, that our Sundays are depressing, that we are lacking in conviviality, and that we have a strange dislike of long words and of elegant phraseology. In the eighteenth century we

had a partiality for the most brutal sports, including gladiatorial combats between women. Our moral behaviour left much to be desired, and our manners at table were no better. Travellers journeying without luggage were badly received, but then it must be remembered that it is only recently that we have become accustomed to "hikers" in this country. Our criminal code was universally approved, in particular the treatment of the accused. Our houses were admired, but our streets were described as narrow and filled with a jostling crowd of pedestrians and a ceaseless string of carts and coaches. In general the standard of living was high: the houses were clean, food was plentiful if not always to our visitors' liking, and what is most important of all, very few of them regretted their stay in this strange land of ours. N. H. B.-C.

CLIMBING DAYS. By DOROTHY PILLEY (Mrs. I. A. RICHARDS). *London: G. Bell and Sons* 1935. 9×5½ *inches;* xiv+352 *pages; illustrations.* 16*s*

This is an account of mountaineering all over the world, written by one who has a sound knowledge of the subject. Beginning with Great Britain and some exciting adventures among the hills of Wales and Cumberland, Mrs. Richards extends her activities to the Alps, the Pyrenees, Corsica, the Rockies, and a short visit to Japan.

The authoress rightly condemns the very hazardous guideless climbing which is liable to be met with at famous climbing centres all over the world. She describes the well-meaning and enthusiastic novice, eager but inefficient, and probably incapable of accomplishing any difficult climb save under the most expert guidance. Nevertheless he does not hesitate to join up with the first casually met stranger who may be as ignorant as he is himself. As Mrs. Richards points out, quoting the case of one "Fortunatus"—who was perhaps a somewhat exaggerated example—the results of such associations may be disastrous. Mrs. Richards however will shock the orthodox, for she seems to consider the art of falling to be an essential part of one's climbing technique. Perhaps the origin of this strange theory is due to the rapidly increasing popularity of short and extremely difficult rock climbs in Great Britain, of a standard that requires the agility of an acrobat. At any rate this book, based as it is on a real knowledge and experience of every kind of mountaineering, makes interesting and delightful reading. C. F. M.

THE VOYAGE OF THE *BOUNTY'S* LAUNCH. As related in William Bligh's Despatch to the Admiralty, and the *Journal* of John Fryer, with an introduction by OWEN RUTTER. *London: The Golden Cockerel Press* 1934. 12½×7½ *inches;* 86 *pages; illustrations.* £2 2*s*

This well-produced volume affords further details on the mutiny of the *Bounty*, though without finally establishing all the causes of that often-debated incident, and the great voyage of the launch under Bligh. Mr. Rutter here prints documents which set forth the events from two points of view. The first, Bligh's 'Despatch' written from Batavia, has not been accessible to the general reader as it was previously available only in the 'Historical Records of New South Wales': the second, the journal of John Fryer, master of the *Bounty*, is printed for the first time.

Fryer, to whom it was due that Bligh and his companions were given the launch in place of the unseaworthy jolly boat by the mutineers, displayed, in common with the majority of the crew, an intense dislike of his superior officer, and his journal was written from memory some time after the events during the voyage of the launch which it records, to defend his reputation against Bligh's charges. The latter referred to the master as a "mean and ignorant fellow," and

accused him of continual obstruction and insubordination. Mr. Rutter reveals that Fryer afterwards had a good record of naval service, so that some allowance must be made for Bligh's strained temper. Fryer, on his part, records in his vivid, if unlettered, prose, many instances of his superior officer's irascibility, stating laconically the reason for the mutiny: "I suppose that they did not like their Captain." The conclusion to be drawn from this book is that the causes of the mutiny in general were the attractions of the South Sea Islands for a crew wearied of their confinement, and the short-lived but fiery outbursts of temper on the part of their commander. It certainly detracts in no way from Bligh's magnificent achievement in navigating an open boat with a starving crew from the Tongas to Timor. As the editor says, it was "a supreme example of the power of discipline over men, when resolutely and unflinchingly enforced."

G. R. C.

WHITE, BROWN AND BLACK: Travels of a Frenchwoman in the U.S.A., Mexico and Abyssinia. By MARCELLE PRAT. Translated by FLETCHER ALLEN. *London: Methuen & Co.* 1935. $7\frac{1}{2} \times 5$ *inches;* viii + 244 *pages.* 7*s* 6*d*

'White, Brown and Black' is an account of journeys in the United States, Mexico, and Abyssinia undertaken by a Parisian journalist who had never before left her native country. Her reactions to each country are vividly recorded and the book is never dull, though the impressions it records are necessarily superficial. In the U.S.A. she was bewildered by the soulless hurly-burly of American life and shocked to find the extent to which Americans are enslaved by "big business." In Mexico her romantic preconceptions were confirmed by the discovery of professional serenaders, real Don Juans, and peons with the faces of Aztecs. Witchcraft and quick divorce are also included in her survey of the country.

The Abyssinian journey is by far the most interesting of the three. She went by way of Singa and Roseires through the closed area of the Sudan to Kurmuk, and thence by mule caravan over the Abyssinian border into the little-known territory of the Bani Shankgul. She was accompanied throughout the journey by an Italian "adventurer" of sinister reputation who upon several occasions rescued her from tight corners. The value of his companionship may be gauged from such utterances as: "Never give way to a nigger: death lies that way!" and, when pressed by Madame Prat to conciliate some threatening tribesmen with backsheesh: "Money to these brutes! I'd rather knock them into a heap!"

During the course of the trek they endured terrible hardships, witnessed orgiastic dances, encountered slave raiders and smugglers, and were finally faced with a mutiny among their native bearers. In the territory of the Bani Shankgul they encamped near a "mystery village" where the existence of great quantities of gold is hinted at, and at this point the Italian went off on secret missions into the jungle, leaving both Madame Prat and the reader in a state of some bewilderment. All this is very exciting, if mysterious.

Unfortunately however the authoress is so obviously given to excessive dramatization and unconscious hyperbole that the book has no geographical or ethnological value. There is no route-map and the itinerary is insufficient to give any but the vaguest idea of where they went or how long the journey took. The reader is continually baffled by this vagueness, due possibly to the necessity for compressing the narrative into limited space. A whole book might profitably have been devoted to the events all too briefly narrated in the last thirty pages.

J. B.

CENTENARY OF THE GEOLOGICAL SURVEY OF GREAT BRITAIN AND OPENING OF THE NEW MUSEUM OF PRACTICAL GEOLOGY

The Centenary of the Geological Survey of Great Britain was marked by the opening of the new Museum of Practical Geology and offices, library, and laboratories of the Geological Survey, performed by H.R.H. the Duke of York on Wednesday July 3. There was a notable gathering of geologists, and especially of survey officers, from all parts of the world. The Geological Society timed its annual conversazione to coincide with the official celebrations. On the second day a morning meeting was held in the lecture theatre of the R.G.S., which was also very well attended. Lord Rutherford received the delegates and Sir John Flett, Director of the Geological Survey, read an address, to which eminent geologists responded. In the evening the delegates and others were received by Mr. Ormsby-Gore, First Commissioner of H.M. Office of Works, and Lady Beatrice Ormsby-Gore at a Government Reception held at the London Museum. On the following day three parties set out under the direction of officers of the Geological Survey, to see the geology of certain parts of the United Kingdom.

The occasion was notable for the unusual opportunities that it gave for unofficial reunions, the extending of hospitality to visitors by the geological dining club, and similar private organizations.

The opening of the new museum is more than a mere replacement of the decrepit premises between Piccadilly and Jermyn Street, which were opened by the Prince Consort in 1851: the new house marks the transference, long meditated, of the Survey to a home in the quarter of science, art, and industry which we owe also to that remarkable Prince. The old isolation of the Survey from related departments at South Kensington is gone: so also is its comfortable proximity to the Geological Society in Burlington House. If there are some regrets they must be compensated by the exchange of utterly dismal and eventually unsafe premises, piled high with material for which there was no room and with soul-destroying grime, for the great open spaces of a palace. It is comforting in these days to find that the sale of the old site amply paid for the stately building that has arisen between the British Museum (Natural History) and the Science Museum.

The structure is worthy of the organization, with its hundred years of solid achievement and tradition, which is at last adequately housed in it: one should remember with admiration and sympathy those whose entire service was spent in the old building. The architect, the Office of Works, and the staff and employees of the contracting companies deserve high praise for the conception and high quality of detail: behind a classical façade is a spacious exhibition hall in which the wishes of the special Board of the Department of Scientific and Industrial Research seem to have been fully carried out. Both the Director and the Curator of the Museum had made an intensive study of modern methods on both sides of the Atlantic, and the arrangement of the collection, types of exhibition cases, provision of diagrams and of a wealth of good photographs, has provided an educational display of the first rank. One has only to pass the building now in the dog-days of mid August to see how geology has become a living science to Londoners and visitors: the halls are thronged. A well-known professor of geography has recently said to the writer: "I do not think I need teach my students physical geography in future, I shall send them to study in the hall

and galleries of the Museum of Practical Geology." The eminent professor might have added "physical and regional geology" with abundant justification.

Once again then the British Geological Survey and Museum, the oldest in the world, has shown the way to modern method of research, co-ordination, and instruction, and its Director, Sir John Flett, must feel on his retirement this autumn that he has seen a great and prolonged effort and many years of labour and organization already crowned with success.

EXHIBITION OF EARLY MAPS OF THE COLONIES

The exhibition of early maps of the British Dominions and Colonies which is now open at the British Museum displays only a small selection from the enormous collection of maps in the Museum, but is very well arranged. It is a historical rather than a cartographical exhibition, designed to interest visitors from the colonies and to assist students of the history of the British Empire. In all fifty-three maps are shown, of which twenty-one are allotted to America and the West Indies, eighteen to Australia, and seven each to India and Africa.

Colonization in the seventeenth century, which was mainly peaceful and followed upon discovery, is represented by maps of Bermuda, which was first settled in 1609, of Newfoundland (1610), the River Gambia (1620), St. Kitts (1624), Barbados (1625), and Madras (1639), although the maps shown are naturally all later than these dates and, owing to lack of space, are not always the best maps available in the Museum. An interesting plan of the Fort of Bombay, engraved soon after we acquired it as part of the dowry of Catharine of Braganza (1661), is also included. A considerable part of the exhibition is devoted to the hard-won conquests and acquisitions of the eighteenth century, the long and bitter contest between England and France for supremacy in North America being well illustrated by a series of contemporary general maps. Notable here, also, are two handsome manuscript plans of Placentia (1708), an important French stronghold in Newfoundland, and of Halifax in Nova Scotia just after its foundation (1749), together with contemporary plans of the siege of Louisbourg by the Massachusetts colonists in 1745 and of the siege of Quebec in 1759. Cape Colony, Demerara and Ceylon, colonies which we annexed from the Batavian Republic in 1795, when it was temporarily in alliance with France, are all shown, the first two on contemporary maps. Expansion in the nineteenth century, which was usually the result of exploration, is illustrated by maps of Australasia ranging from a view of Sydney in 1802 to a map of the Fiji Islands at the date of their annexation (1875), of Livingstone's discoveries in Tanganyika and Northern Rhodesia (1870), of the Burman Empire at the commencement of the first Burmese War (1823), of British Columbia when it became a Crown Colony (1858), of Winnipeg when it was still only an outpost called Fort Garry (1863), and by other maps. The growth of the Empire in Africa during the last ninety years is brought home in striking fashion by a map of West Africa in 1842, which shows no English settlements except a few factories on the Gambia, in the Colony of Sierra Leone (founded in 1788 for liberated negroes) and on the Gold Coast. Among the representations of cities are engravings of Cape Town in 1798, Calcutta in 1794, and Hobart in 1824, coloured drawings of Montreal in 1784 and St. Johns in 1798, and early plans of the capitals of the Australian States.

Some of the maps displayed are very rare and have considerable interest for the student of cartography. The earliest is the chart engraved by Baptista Boazio for Bigges's 'Summarie and True Discourse' of 1589, which shows the route followed by Drake across the Atlantic in 1585–86, when he plundered the Spanish settlements and brought home the unsuccessful English colonists from

Roanoke. The rare map of "Nova Francia" or North America is a fine piece of work, both geographically and as an engraving. Long attributed, on the authority of Colvin, to the English engraver Benjamin Wright, it has now been proved by Dr. Wieder to have been engraved in Holland and published by Plancius about 1592. Another important map is that of the Mogul Empire which the explorer William Baffin drew and published in 1619 from information supplied by Sir Thomas Roe, who was English Ambassador at the court of the Mogul from 1616 to 1618.

While it is evident that the exigencies of space have severely limited the number and size of the maps exhibited, the exhibition has been ably planned, and its educative value will be increased by the full descriptive and historical notes supplied with each map.

EMPIRE SURVEYORS' CONFERENCE

The third Conference of Empire Survey Officers was held in London from July 23 to August 2 under the presidency of Brigadier M. N. MacLeod, Director-General of the Ordnance Survey; the dates of the previous Conferences were 1928 and 1931. The organization was once again in the hands of Captain G. T. McCaw. Delegates came from India, Northern Ireland, and many Colonies, and for the first time some of the Dominions were represented, Canada and South Africa sending their Surveyors-General and Australia its Assistant Surveyor-General. The majority of the meetings took place in the lecture theatre at the Science Museum; but a few, including the opening by H.M. Secretary of State for the Colonies, the Rt. Hon. Malcolm Macdonald, at the Admiralty and others at the War Office and the new Geological Museum. There were excursions to the Royal Observatory at Greenwich, the Ordnance Survey Office at Southampton, and the Admiralty Chart establishment at Cricklewood. A full report of the proceedings will be published in due course.

The Society was represented by Col. Sir Charles Close, Vice-Admiral Sir Percy Douglas, and Professor K. Mason, and entertained all the delegates at tea on August 2, the President deputing to Brigadier E. M. Jack the duty of receiving the guests in his own unavoidable absence. It was generally agreed that the sole adverse criticism that could be made about a very successful Conference was the lack of opportunity for informal talks when the meetings had broken up; the large attendance of delegates and their ladies made it evident that the tea-party at the Society's House was welcomed as to some extent filling this want.

IRISH QUATERNARY RESEARCH

The number of the *Irish Naturalists' Journal* for November 1934, a copy of which we received from the editor, is devoted to papers dealing with the formation of the Committee for Quaternary Research in Ireland, under the chairmanship of Dr. R. Lloyd Praeger, and the first season's work. With help from Irish Universities, scientific societies, and the government, arrangements were made for investigations of a series of peat bogs by Professor Knud Jessen, in which the method of pollen analysis was employed. At Ballybetagh, Co. Dublin, the classical site for the remains of the Irish "Elk," a definite section and profile was established, based upon the sites of dated archaeological finds. The stratification revealed climatic oscillation between the melting of the last inland ice and the beginning of the post-glacial birch period, and analysis showed an interesting small late-glacial flora. Work was also carried out in Northern Ireland, in the Lough Neagh area and elsewhere. Professor Jessen concludes provisionally that in the late Bronze Age the upper layer series in the bogs were formed during a moist period probably contemporary with the sub-Atlantic climatic change on

the Continent, so that the late Bronze Age in Ireland may be correlated with the early Iron Age (Halstatt period) on the Continent. During the later Bronze Age Ireland was still forested to the western coasts and high up the mountains. Definite results must of course await the analysis of the hundreds of peat and soil samples. The value of this method from the point of view of the botanist and the archaeologist is indicated by Dr. Praeger and Dr. A. Mahr, the latter anticipating that it may eventually be possible to draw maps of the human history of Ireland for all consecutive prehistoric periods. The number also contains an article by Dr. J. G. D. Clark on similar work which is being done in the Fens by the Fenland Research Committee. It is to be hoped that the Committee will receive sufficient support to carry out its programme, which promises results the importance of which is not confined to Irish prehistory alone.

GEOGRAPHICAL BASIS OF IRISH LINEN INDUSTRY

In the *Journal of the Manchester Geographical Society* (vol. XLV, 1934–35) Mr. H. W. Ogden discusses the "Geographical Basis of the Irish Linen Industry" and the prominence of Belfast in the industry. Flax is cultivated in many of the countries around the North Sea and Baltic, especially in Estonia and western Russia, being favoured by land of the "podzol" type, the name implying a thoroughly washed-out soil of coarse granular structure. In Ireland the richest podzols occur in the limestone and sandstone areas of the centre and south, but here flax cultivation has not been able to compete with the rearing of dairy cattle and other branches of husbandry. The clay lowlands of north-east Ireland afford podzols of the next best quality for flax, and produce 30 per cent. of the total flax used in Belfast. Here, as in the case of the Low Countries, the establishment of the linen industry has been promoted by abundance of soft water, which is important in the "retting" process. Chemical analyses of Irish streams show that whereas in central and southern Ireland the hardness commonly ranges from 12 to 30, in the north it is never greater than 8·5, and is usually between 3 and 4. The Irish waters however are stated to be under the natural disadvantage of low temperature—little above 50° F.—during the "retting" season. Another favourable factor is the heavy rainfall in the Slieve Croob and Mourne Mountains which ensures abundant water in the soft-water streams rising there.

High relative humidity is advanced as possibly a further natural factor conducive to the production of linen, and figures are quoted indicating higher humidity for linen districts like Armagh and Brussels than for a cotton district such as Manchester. But the argument is weak. There is no indication of the origin or reliability of the humidity curves shown; and moreover comparatively few long records are available of a meteorological element which, though varying to some extent locally, has much the same general value over a large part of the British Isles and vicinity. It must not be forgotten also that high relative humidity used to be considered critical in the Lancashire cotton industry, whereas it is now known that in this case also the real factor is abundance of soft water, as Mr. Ogden has himself shown [*Geogr. J.*, vol. 73, p. 91].

Before the Industrial Revolution Belfast was not much more than a site on a convenient bridgehead between County Down and County Antrim, and its relative insignificance is well indicated on Blaeu's map of 1654, where what is now known as Belfast Lough was then named Knockfergus (Carrickfergus) Bay. It is deeper than Carlingford Lough, gives better access to the interior, and better connection with the coalfields of Lough Neagh, Cumberland, and Scotland.

FLOW OF WATER THROUGH STRAITS OF DOVER

A note in the *Journal* (vol. 75, p. 201) gives an abstract of a paper by Dr. J. N. Carruthers, of the Fisheries Laboratory, Lowestoft, describing preliminary results during 1927 and 1928 obtained with a new type of current-meter known as the "drift indicator" employed at the Varne Lightvessel. A subsequent note in the *Journal* (vol. 77, p. 198) refers to another paper by the same author describing how a marked accentuation of the normal flow of water from English Channel to North Sea in the early part of the winter of 1929–30 with stormy south-west winds was followed by a complete reversal of flow in the latter part with strong north-east winds. Dr. Carruthers has now produced, on the basis of extended observations up to the present year, a further paper on "The Flow of Water through the Straits of Dover as gauged by continuous Current-Meter Observations at the Varne Lightvessel (50° 56′ N.–1° 17′ E.)," Part II (Ministry of Agriculture and Fisheries, Fishery Investigations, series II, vol. XIV, No. 4, 1935). The results indicate that certain conclusions drawn in the first report need modification, and that revision of opinion is likely to be called for by future work.

The result of vector-averaging records relating to some 1700 days of observation is to show that the net or residual flow past the Varne Lightvessel at the depth of 6 fathoms during the period 1927–1931 was what would have taken place had a constant current flowing at the rate of $3\frac{1}{2}$ miles a day towards a north-north-easterly point prevailed. As it is considered that the flow past the Lightvessel at the depth of 6 fathoms is a good indication of the overall movement of the whole mass of water in the Straits it might be stated that about seventeen and a half years would suffice for a volume of water equal to the entire content of the North Sea to flow from English Channel to North Sea. In the previous report the corresponding estimate was twenty-one and a half years.

The strength of flow from Channel to North Sea is greatest in autumn, and least in spring, the percentage rates for the four seasons being: autumn 100, winter 88·9, summer 83·3, spring 77·8. The amount of favouring "following wind" is also greatest in autumn and least in spring; but discrepancies between wind and water-flow in relation to summer and winter point to wind being only partly the cause of the seasonal variation. It would appear that the Straits current is of maximum strength in autumn and minimum in spring for oceanic reasons, and that wind only accentuates, though possibly very considerably, the maximum and minimum. During the period of years concerned the month of December stands out as altogether anomalous: for whereas out of the six Decembers, 1926 to 1931, for which the records have been analysed four were characterized by a very small flow from Channel to North Sea owing to the frequency of "hold-ups" and reversals, no month of any name had so strong a flow in the normal direction as December 1929.

A good deal of space is given to the discussion of an analysis made by Dr. Doodson, of the Liverpool Tidal Institute, of water-flow measurement obtained for the years 1922 and 1923 with another type of current-meter at the Varne. There is an unexplained difference between the currents of these two years upon which neither salinity data nor weather conditions throw any light.

MEMORIAL TO PROFESSOR SHIGETAKA SHIGA

The distinguished Japanese Geographer, Professor Shigetaka Shiga, died 6 April 1927. He had been an Honorary Corresponding Member of our Society since 1916, and an account of his services to his country and to the service of Geography was given in the *Journal* for July 1927 (vol. 70, p. 95). In May 1928 the Society received from H.M. Chargé d'Affaires at Tokyo a letter addressed

to him by Mr. Fujio Shiga, a son of the late Professor, saying that it was decided to proceed with a plan, originating with the Mayor and citizens of Ota-machi (Okazaki), to erect a monument in that city where his father was born, and that in order to transmit to posterity some record of the distinction which he enjoyed in his lifetime, of being an Honorary Member of our Society, it was hoped that the Society might contribute a memorial stone about 5 sun (6 inches) square to the base of the monument.

In response to this the President replied to H.M. Chargé d'Affaires that he would willingly recommend to the Council that the Society should contribute such a stone, but suggested that if it were agreeable to Mr. Shiga the architect responsible should be authorized to select some stone in keeping with the material of the memorial and have it inscribed at the Society's expense: a stone designed without knowledge of the material or form of the monument might prove unsuitable.

The monument is now complete, and stands in the precincts of the Ryuzenji (Yusenji) Temple. In ready acceptance of the President's suggestion Mr. Shiga had a stone specially quarried from Mount Akaishi, inscribed in gold, and built into the foundation. In so informing H.M. Ambassador in Tokyo, he begged only that no steps should be taken to recover from the Society the cost of the stone inscribed as having been presented by the Society; he was anxious to bear the entire cost himself. The President and Council could but reply that they were very willing to accede to this desire of Mr. Shiga if he insisted, and must leave the decision upon this matter entirely to H.M. Ambassador.

By his direction we have now received an account of the ceremony on 8 June 1935. A member of the Embassy staff was delegated by the Ambassador to represent him, and on arrival at Ota-machi was asked to unveil the monument, that stands in beautiful surroundings on the Kiso river, which Professor Shiga used to call the Japanese Rhine. An unworked pillar of rock, bearing an inscription, stands upon a squared base of lighter stone into which the memorial blocks contributed by different nations are inserted; and the whole is enclosed by an iron railing. A handsomely bound volume of photographs of the monument and its surroundings has been presented to our Library by Mr. Shiga. It will give great satisfaction to the late Professor Shiga's friends in the Society that their high appreciation of his talents is thus commemorated in the happiest way, thanks to the generosity of his son, and to the sympathetic assistance throughout of H.M. Ambassador in Tokyo.

NEW TOPOGRAPHICAL MAP OF PALESTINE

The Director of Surveys of Palestine has presented to the Society the first two sheets of a new topographical map on the scale of 1 : 100,000. Palestine has been badly supplied with topographical maps, for apart from a certain number of 1 : 20,000 sheets of the plains published by the Survey Department, there has been nothing but the out-of-date Palestine Exploration Fund series, known as the Kitchener Survey, and certain maps produced by the British and Turkish armies, all prepared from rapid and sometimes rough surveys. The new map will cover the whole of Northern Palestine from the Syrian border to the south end of the Dead Sea in fourteen sheets, normally 45 by 45 cms., covering 2025 square kilometres and each overlapping the adjoining sheet by 5 kilometres. The first two sheets, Jerusalem and Jaffa-Tel Aviv, do not however conform to these dimensions, but are a little larger and fit irregularly into the layout of the whole series. The map is printed in colours and contains a great amount of detail, most of it drawn from reductions of the 1 : 10,000 topocadastral survey. In certain areas there is perhaps more detail than the comparatively small scale will

bear. The contours drawn in red at intervals of 25 metres have been taken, where checking has found them to be satisfactory, from military maps, but the greater portion have been surveyed by plane-table and clinometer. The names are typed in the same old style fount used in the Motor Map published by the Survey Department two years ago and in the larger sizes are excellent. The names of the historical sites, of which there are a large number, are so small that they need a magnifying glass, which is reasonable enough. The spot heights and figures of the contours would have been more legible if they also had been in old style. A second issue of the Jerusalem sheet has these small names retyped, and somewhat more legible: while the tints distinguishing types of cultivation are also improved. The sheets have a 10-km. grid numbered from an origin to the south-west.

The sheets are obtainable in two styles: the "full" in seven colours and the "grey" with faint colours. The latter style should be suitable as a background on which archaeological, geological, agricultural or other information can be overprinted. It is hoped that the Hebron and Haifa sheets will shortly be ready for publication and that all the fourteen sheets will be completed about 1938.

BRITISH POLAR EXPEDITIONS

At the beginning of this year the British Graham Land Expedition's three-masted topsail schooner *Penola* sailed south from Deception Island with defective engines. After a short stop at Port Lockroy she successfully reached the Argentine Island on the Graham Land coast, where the base was established at the beginning of March. Throughout the Antarctic winter, while the dogs were trained and routine observations were maintained at the base, the mechanics were busy on the engine. This work, we now hear, has been successfully completed, though no trials can yet have been made.

The importance of the ship to the expedition's exploratory programme has become very evident from reports received during the last few months. Air reconnaissance has shown that the mountains of Graham Land will make sledging journeys extremely difficult, and therefore short; while the island-dotted coast would appear to be swept by strong currents which make sea-ice travel extremely uncertain, occasionally producing impassable obstacles in the form of open leads or thin ice, cut away from beneath. The first sledging party, which set out in August, was turned back by these difficulties when only 80 miles south of the base.

The expedition therefore are confined for the first part of this season to work north and immediately south of the Argentine Islands. Here there is plenty to be done by parties working with the aeroplane, motor boats, and sledges to keep them well occupied till the end of the year. The Andean chain which forms Graham Land projects from the Antarctic continent as a narrow, horn-like promontory guarding the Weddell Sea. The present base is on the outside of this horn and rather more than half-way up it. Where it joins the main body of the Antarctic there is far wider scope for exploratory work. If, towards the end of the season, the *Penola* is able to transport the base south to the region of Charcot Land and Hearst Land the party will find themselves on a coast which at present is delineated only by dotted lines, and, very possibly, will there find access to the inland ice plateau over which sledging parties may travel towards the head of the Weddell Sea. A final season spent in this district would add greatly to the results which the *Penola* may bring back to England about March 1937.

The opportunity kindly offered by the new Ellsworth Expedition, at present fitting out at Montevideo, of sending necessary spares and replacements to

Deception Island, where the *Penola* or the aeroplane could collect them, is being used to full advantage. The party should thus be well equipped for the second half of their programme; and, in the event of damage to the ship, the Vestfold Whaling Company, through one of their directors, Mr. Naess, a Fellow of the Society, have kindly offered the use of their dock and repair shops at Stromness in South Georgia.

Mr. Augustine Courtauld's party have returned to England from East Greenland, where, under the leadership of Mr. Lawrence Wager, they climbed the mountains which H. G. Watkins discovered from the air in the summer of 1930, and which now bear his name. They left Aberdeen in the *Quest* at the beginning of July and, after encountering bad ice conditions, reached Irminger fjord, about 100 miles from the Watkins Mountains. Dragging hand sledges the climbers of the party travelled up the glaciers of the hinterland, climbed the principal peak on August 16, occupied survey stations on lesser summits of the Watkins Mountains, and returned to the *Quest* after a double journey which had taken fifteen days. On the voyage home Wager's party (five men and two wives) were disembarked at Kongerdlugssuaq, where they will remain throughout the winter doing geological and botanical work. They plan to return to England next summer by a Norwegian sealing vessel.

The Oxford University Ellesmere Land Expedition should also be home by the time this note appears. It will be remembered that ice conditions last season forced them to winter at Etah on the Greenland mainland. But during this spring they crossed to Ellesmere Land and penetrated into Grant Land, where, north of the United States Range, they discovered new mountains of over 10,000 feet.

The Oxford University Arctic Expedition of 1935–36, led by Mr. A. R. Glen, also met heavy ice and were compelled to make a small change in their plans, building their base house in Brandy Bay just west of the northern cape instead of in Rijps Bay just east of it. A despatch to *The Times*, brought back by the *M.S. Polar* which left there on August 22, was published on September 12, with a few photographs. The house was built in what looks like a well-sheltered position on the northern shore of the bay; the coastal survey eastward had begun; an advanced sledging base had been established at the head of the bay, where a newly discovered small glacier gave easy access to the inland ice. It was expected that both the inland winter stations would be equipped by mid-September.

J. M. S.

ITALIAN VERSION OF PLANCIUS'S WORLD-MAP

Once more has Professor Almagià done a service to students of early maps by bringing out an excellent reproduction, accompanied by a suitable memoir, of the excessively rare world-map of Arnoldo de Arnoldi, published at Siena by Matteo Florimi in 1600 ('Il Planisfero di Arnoldo di Arnoldi.' Pubbl. dell' Istituto di Geografia della R. Univ. di Roma, ser. B, num. 2, 1934). Attention was first called to this map forty years ago, during the "Geographentag" at Bremen in 1895, but it has not hitherto been adequately studied. Professor Almagià begins by recalling what we know of the maker and publisher of the map. Arnoldi was a Belgian who worked for some years at Bologna under the famous Italian astronomer and geographer G. A. Magini, preparing the plates for the latter's great Atlas of Italy eventually published by his son in 1620. About the beginning of 1600 he deserted his employer under the promise of

higher pay from Florimi, a publisher of maps and plans (mostly copied from others previously existing), settled first at Florence, and after 1599 at Siena. Besides the big world-map now reproduced, Arnoldi produced half a dozen others for his new employer, whom he left in turn after a couple of years, dying in Rome in 1602 while under contract to return to Magini. From a careful study of the world-map Professor Almagià is able to show conclusively its dependance on the big map of Peter Plancius, known only from the copy preserved at Valencia and reproduced by Wieder in 1929. Not only is the projection—the simple cylindrical—the same, but the whole geographical picture, including the place-names, is virtually reproduced, apart from a certain curtailment of the nomenclature involved by a slight reduction of scale. Many of the subsidiary details of Plancius, such as the small north polar map and the ninefold scale of miles, are also to be found. Here and there Arnoldi has introduced unimportant modifications or additions, and in regard to American discoveries brings in the name of Columbus (entirely omitted by Plancius) and lays stress on the work of Vespucci. One of the other maps made by him for Florimi is a small-scale version of the big one.

The map cannot rank high as an original production, but must not be ignored in considering the cartographical history of the period. A matter of perhaps higher interest is the possibility, shown by Professor Almagià to exist, that a third big planisphere, now unknown, was brought out almost contemporaneously at Antwerp by the firm of De Jode (De Judaeis). It is pointed out that the maps of the continents in the second edition of De Jode's *Speculum Orbis Terrarum* (1593) are all on a uniform scale, and on the simple cylindrical projection, while the geography is also very similar to that of Plancius and Arnoldi. Moreover the map of Europe is definitely stated to have been taken from the large maps of the elder De Jode (he had died in 1589), and in his preface to the Atlas the son refers to his father's idea of cutting up the world-map into more manageable sections. This is thought to show that a big world-map had actually been made by the father before his death, and if this were so, such a map would take precedence over Plancius's, which may to some extent have been founded on it. The statements are perhaps hardly explicit enough for this to be definitely accepted.

The big Arnoldi map was reprinted from the same plate in 1699, by Florimi's successor Petrucci, and of this too only one copy is known.

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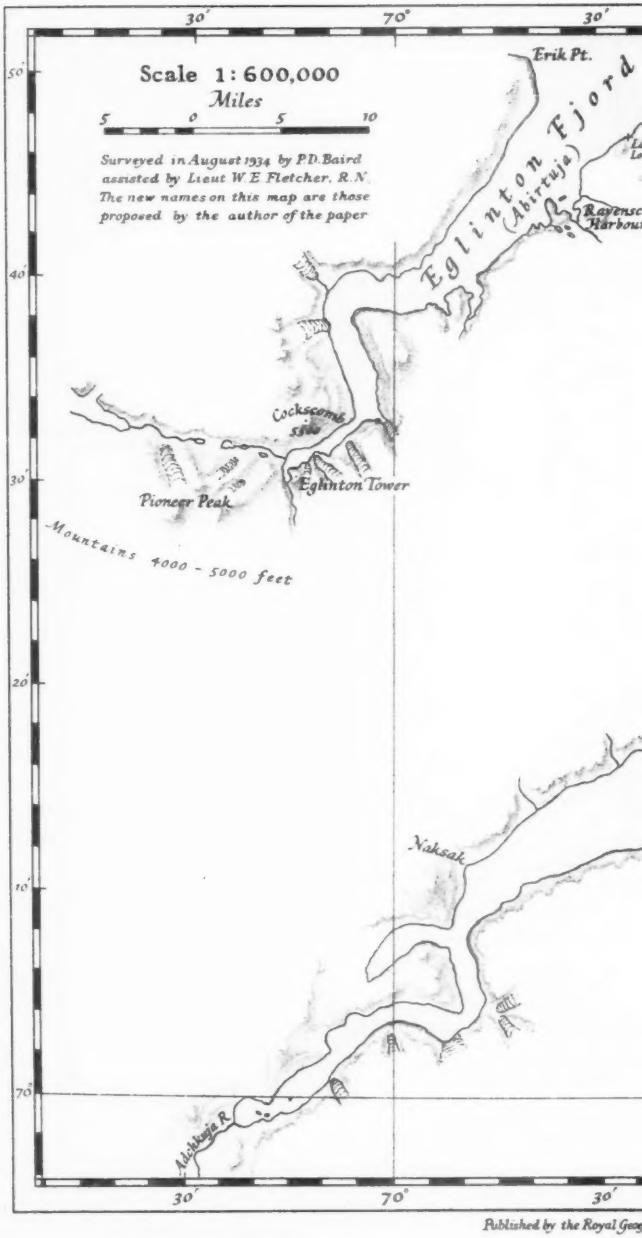

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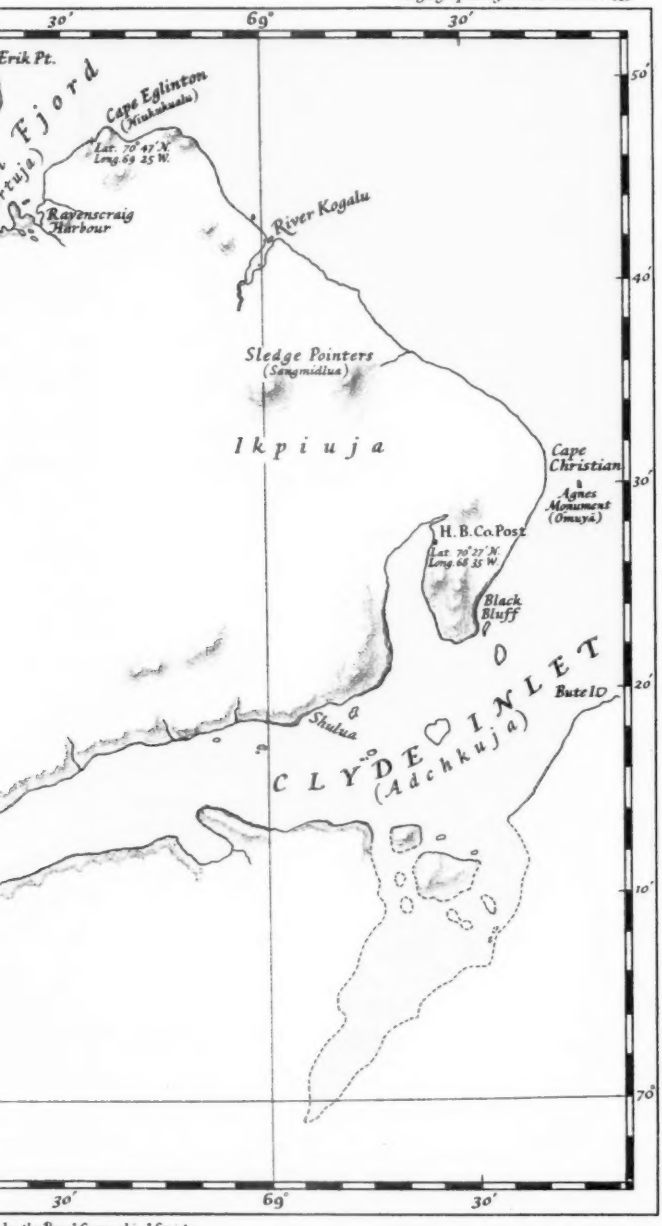

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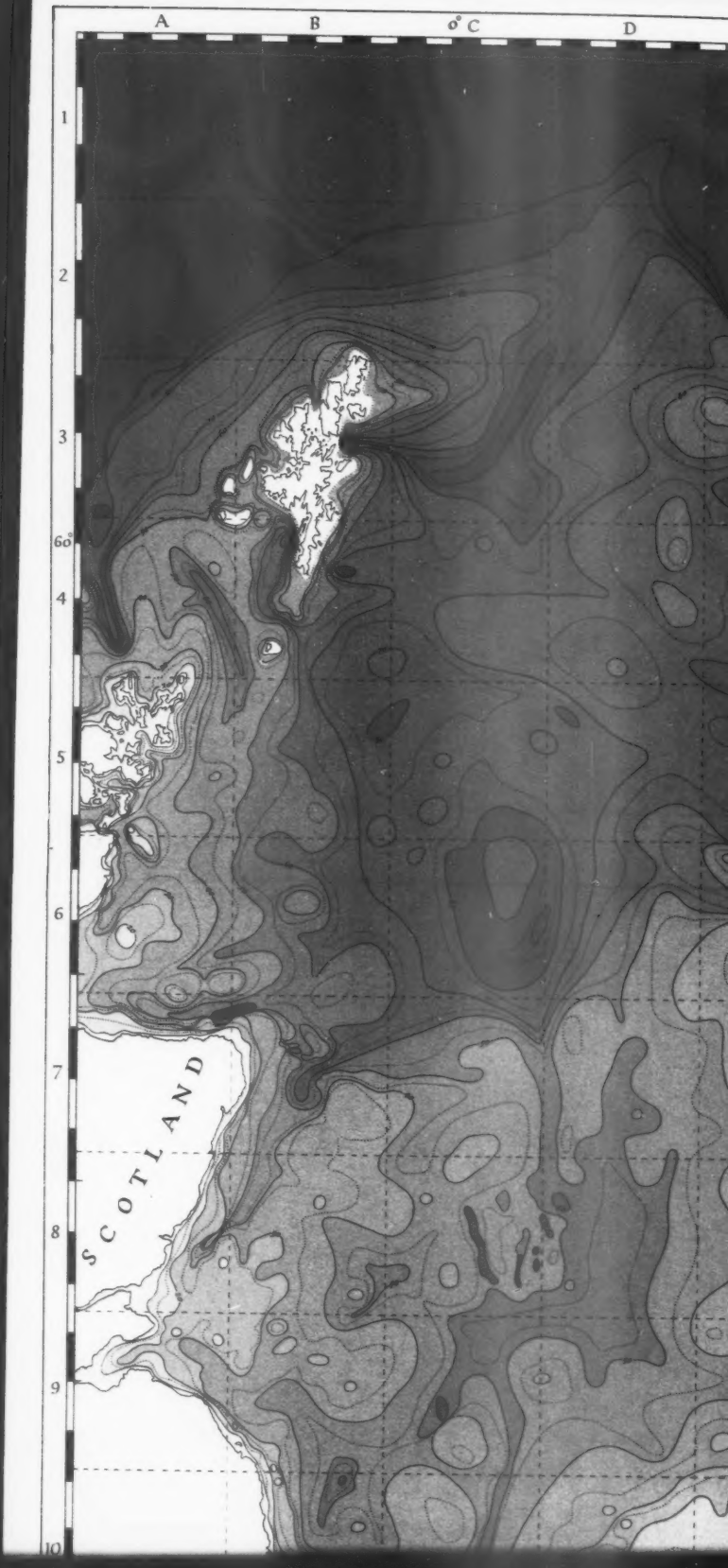
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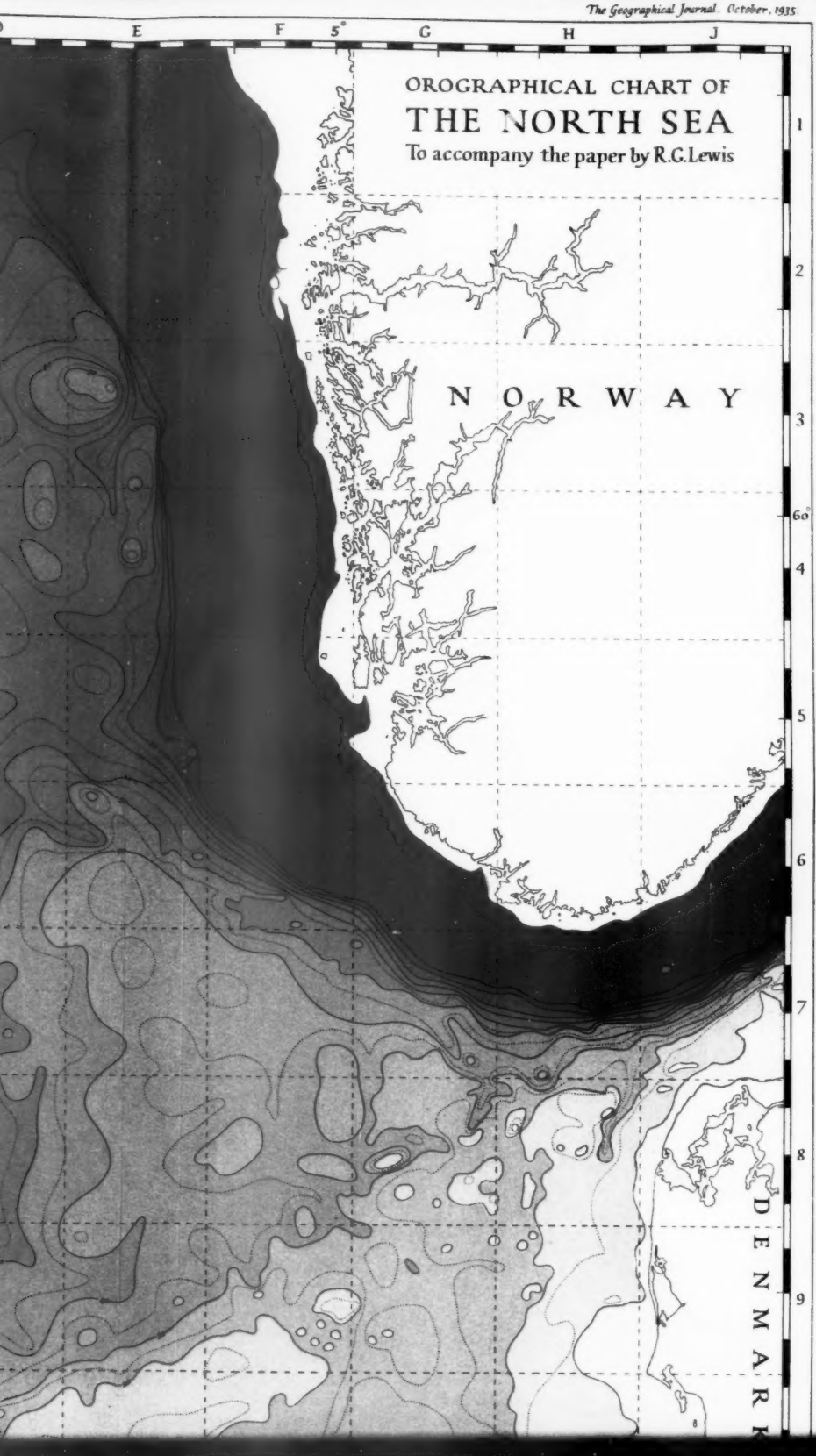
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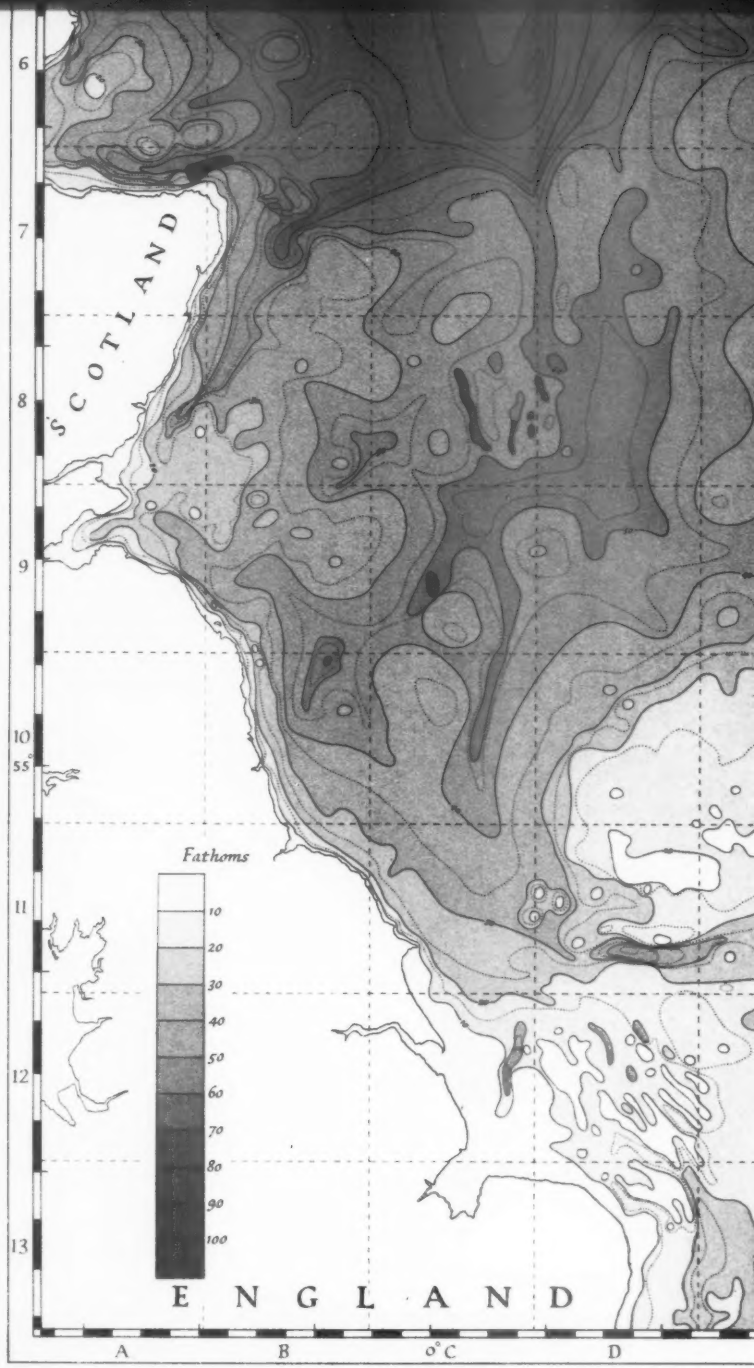

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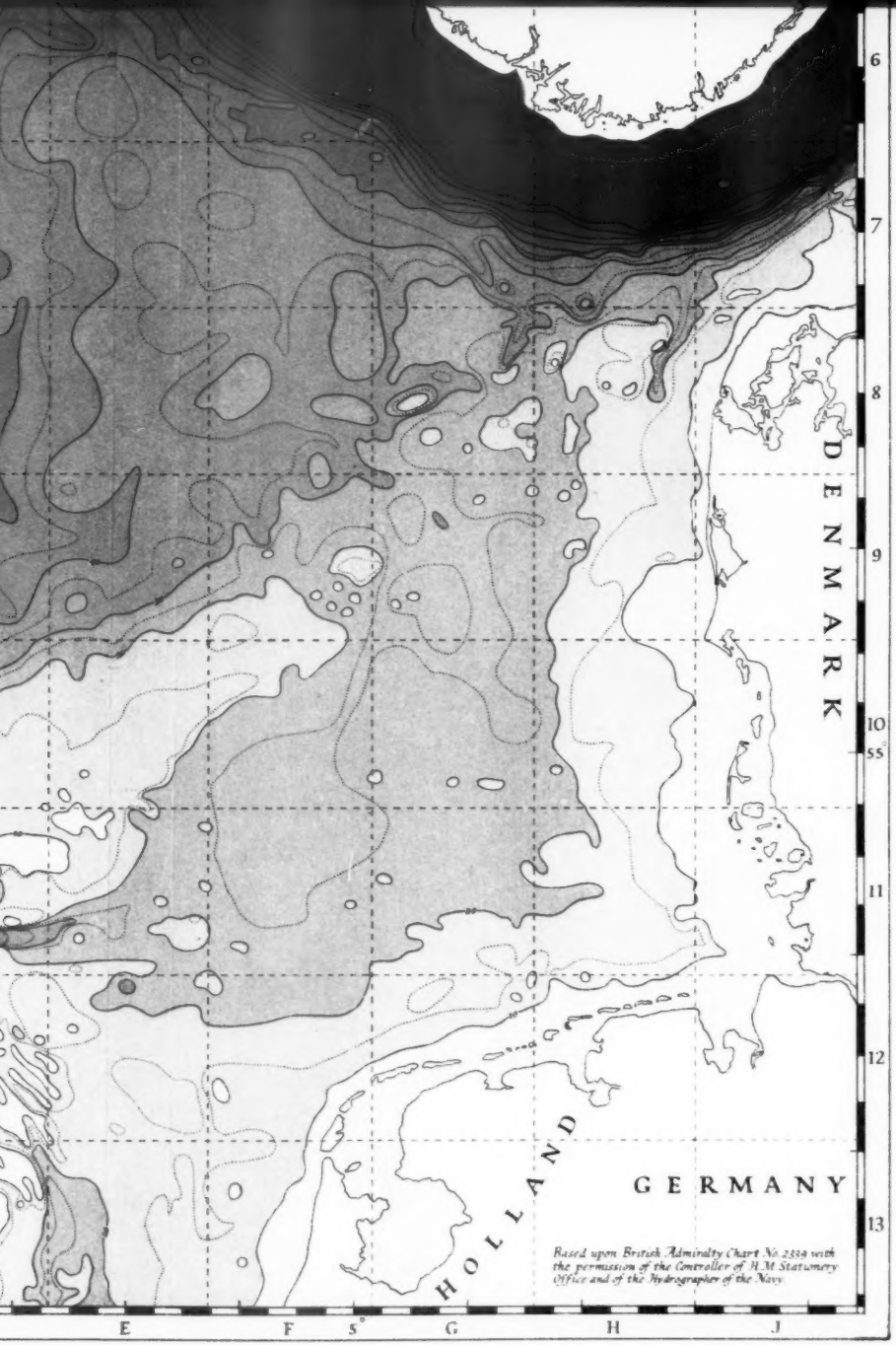

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